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JULY 24, 1998

SIERRA NEVADA SCIENCE REVIEW

Report of the Science Review Team
charged to synthesize new information of rangewide urgency
to the national forests of the Sierra Nevada

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PREFACE

Una gran Sierra Nevada, a large, jagged, snow-covered mountain range to the explorers venturing up from Mexico, is the defining mountain range of California. The Sierra is the source of much of California's natural wealth, from gold that supported Union forces in the Civil War and later fed the economic emergence of the United States on the global scene to the water that now feeds her agriculture, industries, and cities in the Great Valley and along the Pacific coast. The Sierra Nevada is also a place of wonder and inspiration. It is massively sculpted by uplift, erosion, fire, and ice. It is covered by an ever changing blanket of majestic trees, colorful plants, and diverse wildlife. It has vast and open wildnernesses just hours away from millions of people. And, in the past 150 years, it is transformed markedly by human action.

People have inhabited the Sierra for at least 10,000 years. Until a couple hundred years ago, that habitation left most of the Sierra Nevada's natural diversity and processes in place. Lately, our actions upon the land have altered that diversity and those processes. Transforming the Sierra Nevada has been and is done with a purpose: to allow increasing numbers of people to benefit from its natural resources and for some to inhabit the mountains, even if only daily or seasonally. As a result, the Sierra now has roads, dams, reservoirs, power lines, homes, and landscapes imprinted with the long history of human endeavor. The habitats are still rich and diverse, the water clear and pure. But Sierra Nevada ecosystems now contain some species of plants and animals they didn't use to have and they are now missing some that were there for thousands if not millions of years. As a diverse society of people, we have different opinions on whether all of this is good or bad. But it is what we now have in the Sierra.

As people and communities who consider the Sierra to be part of our home and heritage we have a lot of questions. What are the conditions and trends in the Sierra today? What kinds of landscapes do we want to sustain into the future? What kinds of human communities and economies? What kinds of natural resource benefits? What kinds of natural diversity and ecological processes? And what will be the different roles of national forests, national parks, public lands, state parks, and tribal and private lands in providing desired conditions and resources? For answers, we will turn to a complex body of knowledge, technologies, human values, and capital--political, social, human and financial capital. The knowledge will come from the collective body of science and human experience. Both are constantly changing, we hope improving and increasing in value over time. The technologies will emerge in often unpredictable yet profound ways. Our human values reflect our diverse histories and understandings. And the capital that we must draw upon is also changing and shifting.

Periodically, people and institutions of governance make decisions about how they want lands and resources allocated and managed. In the near future, such decisions will be made regarding the national forests of the Sierra Nevada. Those decisions will rest on the body of knowledge and technologies available. They will also be greatly influenced by human values and aspirations and the supply of the various forms of capital with which people must work.

This Sierra Nevada Science Review is a disclosure of what the recent body of science tells us about what a particular group of scientists considers to be some of the significant conditions of

ecosystems, human communities, and natural resources in the Sierra. It is neither the first nor the last such description; it merely builds a synthesis from previous works, most notably the Sierra Nevada Ecosystem Project reports, and it sets a stage for the next rounds of scientific endeavors. Nor is it fully comprehensive and conclusive. It is not possible to be fully comprehensive in understanding or describing such complex places and processes as Earth's ecosystems or its human communities. Aslo, the process of science is never conclusive in the sense that "we have finally figured it all out." Because this review document was produced within a very short period, it is not an authoritative compendium of all science on the Sierra. As the team working on the review interacted among themselves and with other scientists who reviewed drafts of the report, they discovered a range of scientific opinion stemming from either incomplete understanding or legitmate variety in scientific interpretations on some issues. It is difficult to adequately capture that range of opinion and variety of interpretations in a document of this type.

What you will find in this report is, nevertheless, instructive in two very different yet important ways. First, the substance of the review tells us about conditions of some Sierra Nevada ecosystems and social institutions that warrant consideration in conservation planning and management, especially those affected by what happens on national forests. It also tells us that more scientific thinking and analysis are needed before we can make well-informed decisions on some of these conditions. Second, the process used in developing the review discloses how scientific thinking occured and evolved. Science is not a mysterious, linear march to the truth. Like all human endeavors, it is a process of successive approximation that involves inquiry, testing, discovery, dialogue, risk taking, balancing, and judgment. This process of science and its limitations are seldom disclosed to nonscientists. But, in this report, we have disclosed the process so that people will not expect more or less of science than it can deliver to the decision-making process that will use it as a foundation. We have done this in the hard copy of the report, by including review comments in the appendices. We also did it through the internet, on which each draft was posted for full review and comment by anyone so inclined.

As the places we inhabit fill with more people who demand a better life that includes both higher environmental quality and abundant material goods and natural resources, individuals and institutions of governance will increasingly rely on science to inform them of what is possible and what might be the consequences and tradeoffs of alternative courses of investment or action. Science will not deliver single, conclusive answers to such complex choices. Nor will it be infallible or the 20th century analog to divine insight. But science does provide the best, most objective, most defensible source and process for obtaining reliable information on conditions, trends, choices and possible consequences. We ask that you view this science review in light of these perspectives and considerations. The stage is now set for the next round of inquiry, testing, discovery, dialogue, balancing, and judgment to improve national forest management, conservation, and collaboration in sustaining the ecosystems, resources, and communities of the Sierra Nevada.

Hal Salwasser
July 24, 1998

SUMMARY

Background. In January, 1998, the Pacific Southwest Region and Pacific Southwest Research Station of the Forest Service initiated a collaborative effort to incorporate new information into planning future management of Sierra Nevada national forests. The project, known as the Sierra Nevada Framework for Conservation and Collaboration, will incorporate the latest scientific information and broad public and intergovernmental participation in watershed-scale ecosystem planning. The national forest portion of the project, which allows for forest plan amendment, is expected to be completed by mid-summer, 1999.

The Land and Resource Management Plans for national forests in the Sierra Nevada were amended in 1993 to incorporate interim direction for habitat conservation for the California spotted owl. The Regional Office of the Forest Service subsequently assembled an interdisciplinary planning team to develop a draft Environmental Impact Statement to replace the interim direction with permanent management direction. On a parallel track, in 1993, the U.S. Congress charged the Pacific Southwest Research Station to conduct an independent science assessment of conditions and trends in ecosystems and communities of the Sierra Nevada ecoregion; this report, known as the Sierra Nevada Ecosystem Project (SNEP), was published in 1996 and 1997. In late 1996, the Secretary of Agriculture chartered a California Spotted Owl Federal Advisory Committee to evaluate whether the Forest Service's Revised Draft Environmental Impact Statement (RDEIS) for California spotted owls adequately integrated all available and significant information relevant to management of national forests in the Sierra Nevada. The Committee's December 1997 report concluded that the RDEIS was inadequate in its current form for either owl conservation or ecosystem stewardship.

In response to the Califormia Spotted Owl Advisory Committee's report, and in order to complete the process of amending land management plans for Sierra Nevada national forests, four related tasks in the Sierra Nevada Framework were identified. Task 1, a letter of clarification to Forest Supervisors, was completed on May 1, 1998 and is being implemented pending completion of Forest plan amendments (i.e., Task 3). This science review report is the completion of Task 2. Task 3 and the collaboration process that has been called Task 4 are now underway, building on the foundation set by Tasks 1 and 2.

Task 2 Science Review Team. Seven scientists from the Pacific Southwest Research Station were formally chartered on June 12, 1998, to provide the Pacific Southwest Region with a synthesis of current science information with attention to issues of urgent priority at rangewide scales in the Sierra Nevada. Some members of the team had been working on the review informally for several months prior to the formal charter. In their review, the team was asked to consider both environmental and socio-economic information, with special emphasis on relationships to management and geographic scales appropriate for conservation and management.

Report Development and Presentation. This review was conducted using an expanding and adaptive process. An initial draft served as a discussion vehicle for the Science Review team. The draft was distributed to other scientists who added information and edited and evaluated each issue. Subsequent draft reports and the final draft were posted on the PSW Website (psw.fs.fed.us/sierra/) for full public and scientific access and comment. The final draft (July 10, 1998) was also subjected to a formal blind scientific review by eight scientists representing broad geographic, organizational, and scientific interests.

Because of the nature of the information considered and the issues identified in the Review, results range in presentation from broadly framed ecological systems and processes, to fine-scale relationships of individual species. Candidate issues were identified and evaluated following five criteria and, when selected, were presented in the report under one of the following categories (Priority Issues for Conservation, Priority Considerations for Implementation, and Issues for Further Clarification). Each issue is characterized with: a brief synopsis, related references, the basis for inclusion, the geographic region of concern, primary scales for consideration, and relationships with national forest management.

Overview of Issues

Priority Issues for Sierra Nevada Conservation. Seven conservation issues were identified by the team and reviewers to be of highest priority for national forest management in the Sierra Nevada. Each is considered to be of urgent concern at broad geographic scales and requires a common conception and coordinated approach to problem analysis and evaluation, planning, and monitoring. These issues and a brief description of a portion of the basis for inclusion are presented below:

I. **Cultural, Demographic, and Socioeconomic Changes.** Demographic and socioeconomic conditions continue to evolve in the Sierra; many regard them among the primary factors governing the effective achievement of ecosystem management goals. These changes need to be more fully articulated and examined so they can be more carefully considered in planning and management.

II. **Fire and Fuels.** Fire is a key evolutionary force that has influenced Sierra Nevada ecosystems for millennia. Fire suppression has altered fire regimes, including its role as an evolutionary force, and/or created conditions that are very different from historic ecosystems. Human habitation in the urban-intermix zone and existing wildland-fuel conditions pose significant threats to human life and property; federal, state and county financial resources; wildlife and fish habitats; and socially valued ecosystems.

III. **Old-Forest Ecosystems:**

Forest Conditions of Structurally Complex Forest Types. Old forests are unique ecosystems in the Sierra Nevada. They support critical habitat for dependent flora and fauna, provide ecosystem services, and have high social value. Despite differences of interpretation, all estimates indicate that the abundance of old forests and the structural complexity of low- to mid-elevation forests have declined significantly since post-1850 settlement, to the detriment of associated species and ecosystem functions. Altered fire regimes have greatly changed vegetation developmental patterns, and future national forest management can directly and significantly affect the quality and quantity of old-forest ecosystems.

California Spotted Owls. The California spotted owl is listed as a Forest Service Sensitive Species in Region 5. It is known to be closely associated with old-forest attributes (large, old trees; large snags; large, downed logs). All owl demographic study areas within the Sierra Nevada show significant recent population declines. The two other subspecies (northern spotted owl and Mexican spotted owl) have both been federally listed as threatened.

Forest Carnivores. The fisher is believed to currently occupy less than one-half of its known historic range in the Sierra Nevada. The American marten appears to occupy much of its known historic range, but our understanding of marten distribution and abundance is less precise than for the fisher. Data on occurrence of wolverine and Sierra Nevada red fox in the Sierra are not conclusive. Each of the forest carnivores, with the possible exception of the marten, appears to have suffered significant declines in its range and abundance in the Sierra Nevada.

IV. **Aquatic, Riparian, and Meadow Ecosystems:**

Low- to Mid-Elevation Ecosystems. Aquatic/riparian ecosystems have been ranked as having greater biodiversity than adjacent uplands and provide significant food and habitat for upland species; they are recognized as one of three most altered and impaired ecosystems in the Sierra Nevada. National forest management could play a significant role in recovery from historic impacts and minimize impacts from recent and continuing changes.

High Elevation Ecosystems. Historic land, meadow, and aquatic management in high elevations of the Sierra Nevada have had significant effects on vegetation and aquatic conditions. Declines in frog populations have been steady and widespread. Golden trout and Lathontan cutthroat trout are federally listed, and fish stocking issues remain controversial. Broad-scale, species-level issues require examination and implementation with watershed and broader linkages.

Frogs and Toads. Over 50% of the 30 native Sierra Nevada amphibian species have experienced population declines. The causes of frog and toad population declines are not wholly understood and differ depending on latitude, altitude, and species. Maintenance of existing populations, restoration of declining populations, and maintaining "connections" among populations will increase the likelihood of survival and improvement of these species' population status.

Willow Flycatcher. The Willow Flycatcher is listed as a California endangered species and one of its subspecies is proposed for federal listing. Willow Flycatchers have declined rapidly throughout the Sierra Nevada and have been extirpated from most of their former range. Loss of the known remaining populations is likely without rapid mitigation and restoration efforts. National forest management actions have the potential to reverse population trends.

V. **Lower westside conifer/hardwood zone.** Mature hardwoods of the lower conifer zone are critical components to Sierra Nevada ecosystems. The many historical, current, and anticipated natural and human events affecting many elements of these communities need to be fully considered in future land management actions.

VI. **Roads.** A road system is essential for the use and management of Sierra Nevada national forest lands. Road closure, decommissioning, obliteration, reconstruction, and active maintenance can significantly reduce negative impacts of roads to ecosystems, but such actions require balancing access needs, costs, and ecosystem effects.

VII. **Bighorn Sheep.** Native Sierra Nevada bighorn sheep are a genetically unique subspecies of mountain sheep found only in the central and southern Sierra Nevada. They are listed as threatened

by the State of California and face likely federal listing under the Endangered Species Act. Recent data indicate the sheep are at high risk of extinction. Federal and state management actions could significantly improve chances of Sierra Nevada bighorn survival, reverse population declines, and secure population establishment. However, changes in lion protection status have made control of depredation difficult.

Priority Considerations for Implementation. The Science Review team identified three issues for special consideration related to implementation of national forest management actions in the Sierra Nevada. While the team was not charged to recommend specific conservation goals or objectives or to outline management strategies or solutions, they recognized that achievement of conservation and land management goals has been hindered by institutional barriers, or lack of attention or understanding of social forces of change. Implementation considerations of note were:

I. **Adaptive Management and Monitoring**. Ecosystem management depends on continual adaptation to new information and changing conditions. Monitoring is an important source of new information. Consequently, discussion regarding the need for effective monitoring has increased in recent years, with emphasis on both predictive and retrospective approaches. Increased attention to monitoring in the Sierra Nevada has led to the conceptual design of a comprehensive monitoring system that would transcend agency boundaries. The conceptual model must now be tailored to the specific direction for land and resource management that takes shape over the next few years.

II. **Effects of California Spotted Owl (CASPO) Interim Management.** CASPO guidelines were put in effect to benefit spotted owl habitat and population trends. Because they were intended to be in effect only two years, but have actually remained for five, there is considerable anecdotal discussion about the effects of CASPO interim management on ecological and socio-economic conditions of Sierra Nevada national forests and communities. No regional or rangewide evaluation has been made, and little information is available to provide a serious review at any scale.

III. **Reinvestment and Funding for Ecosystem Management.** Based on direct resource values, Sierra Nevada ecosystems produce about $2.2 billion worth of commodities and services annually. Reinvestment in the ecosystems that produce the commodities and services is extremely low. To achieve our goals of sustaining and enhancing Sierra Nevada ecosystems requires ways of returning a larger percentage of the value from public resources to local management and conservation.

Issues for Further Clarification. Uncertainty leaves not only unanswered questions, but leads to different interpretations within the scientific community. Ideally, the products of scientific research and discourse would give clear resolution to conservation and management issues. Unfortunately, the scientific process in environmental fields rarely provides such finality. Conditions are so complex that uncertainty almost always remains. Such uncertainty, unresolved by SNEP, continues over several issues regarding Sierra Nevada ecosystems. These include: conservation of old-forest and aquatic/riparian ecosystems, management of livestock and packstock grazing, setting priorities for biodiversity conservation, and the roles of science and collaboration in land and resource management. These issues are presented in this report to set the stage for further scientific analysis and discussion. This report does not attempt to resolve all scientific questions, but to briefly clarify the nature of the dialogue that still needs to occur.

INTRODUCTION

BACKGROUND

The Land and Resource Management Plans of the 10 national forests (Forest Service Pacific Southwest Region) in the Sierra Nevada were amended in 1993 through an Environmental Assessment. The forests include the Modoc, Lassen, Plumas, Tahoe, Eldorado, Stanislaus, Sierra, Sequoia, Inyo, and Lake Tahoe Basin Management Unit, which is, for convenience, considered a national forest in this report. The purpose of the 1993 Environmental Assessment was to put into place interim management direction based on new information about habitat needs for California spotted owls. The interim direction was intended to be in effect for 2 years while a longer-term plan (i.e., an Environmental Impact Statement) was developed for owls. An interdisciplinary team assembled in 1993, and later published the Draft Environmental Impact Statement For Managing Spotted Owl Habitat in the Sierra Nevada National Forests of California (DEIS; USDA Forest Service 1995) for public review in 1995. Based upon public comments, a Revised Draft Environmental Impact Statement (RDEIS; USDA Forest Service 1996) was prepared for public distribution by August 1996. Both documents directly addressed management of several rangewide issues in addition to spotted owl conservation, namely fire, viability of other wildlife species of high concern, roadless areas, aquatic and riparian habitat, and forest health.

Meanwhile, responding to collective public and scientific concerns about the health and sustainability of Sierra Nevada ecosystems, the U.S. Congress mandated the Sierra Nevada Ecosystem Project (SNEP) in 1993. SNEP was an independent scientific assessment of conditions and trends in ecosystems and human communities of the Sierra Nevada ecoregion. Analyses involved more than 150 scientists from universities, public agencies, and the private sector. The final reports of the Project were published in four volumes in 1996 and 1997. SNEP assessments covered all lands, ownerships, and ecosystems in the Sierra Nevada and addressed physical, ecological, and social issues at multiple scales. Although general strategies for maintaining health and sustainability of ecosystems were described by SNEP, the reports were not developed as decision-making documents following procedures of the National Environmental Policy Act (NEPA). The reports identified the need for new collaborative and nontraditional approaches to solving resource problems.

In August 1996, responding to public concern over the congruence between SNEP and the RDEIS, the Secretary of Agriculture chartered a California Spotted Owl Federal Advisory Committee (FAC) to evaluate whether the Forest Service's RDEIS adequately integrated all current and available significant information, specifically that compiled in the SNEP reports, relevant to the management of National Forest System lands in the Sierra Nevada. The FAC report, published in December 1997 (FAC 1997), concluded that the RDEIS was inadequate in its current form as either an owl or an ecosystem management Environmental Impact Statement. The RDEIS, thus, was not distributed and an alternative process for addressing management of Sierra Nevada national forests was begun in early 1998. This has become known as the Sierra Nevada Conservation and Collaboration Framework. The collective goal of the Framework is to incorporate new information that will help to sustain and enhance Sierra Nevada ecosystems. Four discrete but interlinked tasks have been identified, as follows:

Task 1. This task was to provide initial advice on improving the consistency of management with newly assembled information. On May 1, 1998, Regional Forester Lynn Sprague issued a letter to the supervisors of the national forests in the Sierra Nevada that clarified existing guidelines and identified relevant new information to consider in planning. The focus of this guidance was to improve conservation options for California spotted owls, forest carnivores, old-forest ecosystems, aquatic and riparian ecosystems, fire and fuels, and roads and roadless areas. Recommendations in the letter were developed in conjunction with a science review team from the Pacific Southwest Research Station.

Task 2. This resulted in the present report and provides a review and synthesis of current scientific information, with attention to issues of urgent priority at rangewide scales in the Sierra Nevada. A science team comprising seven scientists from the Pacific Southwest Research Station (see Appendix IV) developed the report. The review began in early June 1998 and was completed in mid July 1998 with production of the current report. Details of the objectives and process are given below in the section "Charge to the Science Team" and in Appendix III.

Task 3. Information from the Task 2 science review, combined with input from collaborative public discussions that the PSW Region will conduct in summer and fall 1998, will help the Regional Forester decide on a strategy for updating the Sierra Nevada national forest plans. This process, using National Environmental Policy Act procedures, will begin by mid summer 1998, and is expected to be completed in July 1999.

Task 4. This an ongoing collaborative effort to develop interagency coordination for achieving conservation goals in the Sierra Nevada. An interagency executive committee directs a staff group to explore and conduct projects of common interest in the Sierra. Forest Service-directed Tasks 1-3 are coordinated with projects of the interagency group, as well as with activities of the California Biodiversity Council.

CHARGE TO THE SCIENCE TEAM

The charge to the science review team is described in a letter dated June 12, 1998, from PSW Research Station Director, Hal Salwasser, to Assistant Station Director, Garland Mason (see Appendix III). The team was asked to develop a report that identifies and synthesizes new information from recent science studies, such as SNEP, of urgent attention to national forest management in the Sierra Nevada. The report will help focus the PSW Region's efforts to conduct regional planning and amend land management plans for the Sierra Nevada national forests. The team was to consider both environmental and socioeconomic information, considering at least those issues addressed in the Task 1 letter. An emphasis of the review was to point out relationships of the information to management, and geographic scales appropriate for conservation and management.

SCIENCE TEAM APPROACH AND ORGANIZATION OF THE REVIEW

General approach. Recent science assessments, especially those compiled in the reports of the Sierra Nevada Ecosystem Project, draw attention to opposing conditions about the Sierra

Nevada. On the one hand, there are some situations, places, species, or ecosystems where urgent attention is called for to address imminent or irreversible losses or changes. On the other hand, assessments point to the high level of biodiversity and ecosystem functioning that persists in general throughout the Sierra Nevada, especially above the foothill woodlands. As pointed out in the SNEP reports, most of the problems of the Sierra Nevada can be solved, although the time scale and degree of solution will differ depending on the problem. In this report, we attempt to highlight issues where urgent attention to problems is called for, and where national forest actions could be effective. In identifying problem areas here, we acknowledge the generally high quality of biodiversity retention and ecosystem function that is the background condition in the Sierra Nevada as described in recent summary literature.

The approach taken in the science review was framed by several pre-existing conditions, including the charge letter and other criteria listed below. A logical tension existed between organizing the review around an ecosystem framework or an issue-specific framework. The team felt the best solution was to take a mixed approach. Identifying urgent issues where new information and other criteria below were met resulted in a heterogeneous set of issues. For instance, we identify issues as whole ecosystems (old forests, aquatic), as ecological processes (fire), as human actions (roads), and as single species (California spotted owls).

The review team recognizes that national forest management is striving to improve ecosystem management as a standard operating approach while (at the same time) addressing issue-driven priorities. We strongly encourage emphasis on integration and coordinated management, but we also acknowledge that "an ecosystem approach" is neither well-defined nor necessarily adequate to deal with issues and elements of biodiversity that are of high concern. The dilemma of how to integrate ecosystem and issue-driven approaches is currently unresolved in the science community, and for now it remains with policy makers and managers to contend with during implementation.

Further, the review team believes the Forest Service can and should be a pioneer in the application of new technologies (Geographical Information Systems [GIS], Geographical Positioning Systems [GPS], remote sensing, etc.) to ecosystem and landscape-scale management of federal lands (e.g., Hunsaker et al. in prep.). We now have the tools to undertake cumulative effects analyses at local to broad spatial scales, and the team encourages the use of these tools in the upcoming planning efforts for the Sierra Nevada, as the issues we and others raise are nested in that analytical framework.

<u>Choice of Issues.</u> "Issues" were chosen here not in the meaning of the National Environmental Policy Act but to identify specific resource concerns based on the following criteria:

- Charge letter. The charge letter (Appendix III) identified much of the organizational structure for the report, including the geographic focus (10 national forests) and initial list of resource concerns (issues) to be addressed. These issues derive priority not only from science, but also from policy (including Forest Service national office) and social arenas. The charge letter directs the team to consider issues that will help focus the Forest Service Pacific Southwest Region's efforts to conduct regional planning and amendment of national forest plans.

• New information. Information was generally considered new if it was reported after 1992. Significant older information was highlighted, however, if it appeared to have been overlooked or not well incorporated in recent management direction. Issues without significant new information were not included, despite their potential significance. New information included not only aspects previously unknown, but also confirmations of conclusions from previous studies; improvements in certainty or risk of previously known conditions and trends; confirmation of anecdotal assumptions; geographic extensions of previous knowledge; and studies that yielded greater detail and specificity.

• Broad-scale concerns. Issues were selected that were considered to require conceptual interpretation, planning, and coordination at scales of multiple-forests to rangewide, or, if they affected portions of the Sierra Nevada but were considered significant enough that their importance rated them with broader-scale issues. Issues were included that have conservation interest at state, national, or international levels.

• Urgency for attention. Issues were selected where conditions are changing quickly enough that immediate action is needed, i.e., where conditions would degrade rapidly without renewed attention, and where practical national forest actions could have significant effects on improving conditions.

• Not well addressed elsewhere. Issues were selected if current management has not adequately addressed urgent situations. Significant issues were excluded if they are being well addressed by current national forest programs and laws (e.g., programs attending the Endangered Species Act, National Historic Preservation Act). In some cases, issues were highlighted where existing regulations or laws are not being adequately implemented or have failed to provide protection.

Choice of Species. Although the team supports ecosystem approaches to management where they are appropriate, individual species can "slip through the cracks" when planning and evaluation focus at ecosystem levels. Thus, the team selected a small number of individual species as priority issues, recognizing that a much longer list of species-of-concern exists for the Sierra Nevada (see section, Priorities for Conservation of Biodiversity). The species emphasized in this report were selected for one or more of the criteria described above, and especially for the following: they were previously identified as key issues; they appear to have promise as "umbrella" species--species whose conservation can assure the maintenance of many other species; their situation appears to be particularly tenuous and urgent at this time.

Although formal risk assessments and priority-setting models have been developed, they are nascent and incomplete for the Sierra Nevada. Because of the importance of evaluating and ranking other species-of-concern (and other biodiversity-of-concern) that have been identified by others in the Sierra Nevada, we highlight this topic in a later section of the report (see, "Issues for Further Clarification"). There we recommend that the PSW Region and Research Station use information from ongoing risk assessments (SPAMT 1998) to help focus the species- and biodiversity-specific elements of planning.

Socioeconomic Issues. The team recognizes the difficulty of assessing new knowledge in all of the socioeconomic issues extant in the Sierra Nevada today. As well, there are many ways to present socioeconomic issues. The evolution of human values, power, and behavior provides a

context for understanding issues stemming from the interaction of human and biophysical aspects of Sierra Nevada ecosystems. Thus, the issue statement titled "Cultural, Demographic, and Socioeconomic Changes" can be read as a set of issues or, perhaps more usefully, as background and context for the other issues in this review. The issues listed in this section are synthesized from a number of disparate sources: the publications listed in the Issues section (Synopsis), from many discussions, interviews, and conversations, and from personal observations and interpretations made by the review team. Thus, for this section, we did not list specific citations to support each statement.

Issues Not Selected. The team recognizes that the selection of issues has an arbitrary component, determined partly by team composition. An initial, longer list of issues was used for early discussion. Because some of these were raised also by reviewers, we list them here as potential for special treatment in the upcoming NEPA processes:

- Specific itemization of socioeconomic issues (see section above);
- Grazing;
- Biodiversity (both collectively and individual species, including northern goshawk);
- Recreation;
- Invasive alien species;
- Air quality.

As noted above, several reviewers also advocated an ecosystem rather than an issues (i.e., mixed) approach.

Section Organization. The charge letter to the science team (Appendix III) provided the structure for organizing the report. Overall organization and individual headings under sections are as follows:

1. Priority Issues for Conservation

Issue. Each selected ecosystem, species, condition, or process is identified.

Synopsis. Each issue is summarized by a brief synopsis containing limited contextual background and synthesis of select, key new information relevant to condition, trend, urgency, impacts, and management. Primary new or significant older references are cited. Peer-reviewed references could not be sorted from other literature, although unpublished reports, agency reports, and personal communications typically are not peer-reviewed.

Additional References. New references not cited in the Synopsis are noted.

Basis for Inclusion. Justifications for selecting the issue are given, following the criteria indicated above.

Geographic Region of Concern. The primary geographic area over which national forest attention would focus for the issues is noted here. This section is intended to indicate geographic extent and not to target specific areas for high-priority attention, which is the subject of the following heading.

Primary Scales for Consideration. This section notes the significant management scales for the issue within the geographic region of concern. Although all issues brought forward were considered to require coordinated planning, evaluation, and monitoring at broad scales, approaching rangewide in several cases, implementation scales vary from local to subregional. Implementation is most effective when planning is interconnected among scales. Coordination at wide geographic scales is not meant to preclude flexibility in local implementation, which is essential for adaptive management, but to provide the needed landscape-scale perspective, that is, common conceptual interpretation and coordinated solutions. Geographic scales mentioned are referenced to the Calwater standardized hierarchy of watersheds (Brandow 1994) for the sake of approximate sizes only. Other systems (e.g., McCammon 1994) provide similar delineation along hierarchical watershed boundaries.

Relationship with National Forest Management. The science team was charged with synthesizing high-priority issues and bringing forward new science information, not with recommending management approaches or actions. Nevertheless, the team was asked to highlight links to specific elements of management relevant to each issue, in the hope of assisting managers in their consideration of each issue. In this section, cross-references to other Issue sections in the report are noted in upper-case titles.

Redundancies in statements among issues are a consequence of the interrelationship among issues and were purposely left to indicate linkages and cross-references.

2. Priority Issues for Implementation

This section identifies issues that the team believes are significant for implementing both a broad ecosystem approach to national forest management and for addressing individual issues of urgency identified in this report. Headings were used as in Priority Issues for Conservation.

3. Issues for Further Clarification

Five issues--old-forest ecosystems, aquatic and riparian management, grazing, priorities for conservation of biodiversity, and science and collaboration--were chosen to highlight for further discussion. For each of these, and for different reasons, conflict or uncertainty has surfaced that has led to important questions in developing management direction that the science team was unable to resolve in the time allotted to this review. Expansion of several of these topics is in Appendix I.

Incorporation of Future New Information. We acknowledge that incorporation of new technical information into management is dynamic and ongoing. Management planning must allow for continual adaptation to new ideas. The review team was under a very short timeline to produce the report, meaning that some current information and interpretations are likely to have been missed. Further, ongoing advances of science, as well as continual experience-on-the-ground, mean that management must be a learning process, adapted to regular input of new information. What the current report brings forward is neither the end of new information, nor the end of new ways of looking at old information.

PEER SCIENCE REVIEWS AND PUBLIC COMMUNICATION

This review was developed using an expanding, adaptive review process, similar to that used in SNEP. An initial draft was used as a discussion vehicle for the PSW science review team to discuss and edit. This draft was then distributed to other scientists (Forest Service and external, Appendices V and VI) who similarly added, edited, and evaluated the list of topics and content under each issue. Drafts and final report were posted on the PSW Website (psw.fs.fed.us/sierra/). Comments from many scientists and specialists were received and used, as appropriate. The last draft was subjected to a blind, scientific review administered by Dr. Garland Mason, Assistant Director, PSW Research Station. For this purpose, eight scientists reviewed the draft and made extensive comments. Because of the volume of excellent, critical reviews received late in the process, not all could be incorporated into the report. Because these are essential for further development of the regional planning process, redacted (identities removed) peer reviews are duplicated in Appendix II). Responses to all reviews evaluated (those received in time) will be kept on file at the PSW Research Station and posted eventually on the PSW website. The report was developed under the administration of Dr. Garland Mason and direction of Station Director Dr. Hal Salwasser.

ACKNOWLEDGMENTS

Many people provided information and review on extremely short notice and under frustratingly short deadlines. We sincerely thank all our colleagues and reviewers who took valuable time to improve this document, providing information on recent research, clarifications of literature, and who frequently pointed out shortcomings in our drafts. As part of the evolving process for the NEPA effort ahead, we pass the review comments we received to the Task 3 EIS and Science Integration Teams, committing to bring forward ideas and critiques from the present effort to the next phase of work.

PRIORITY ISSUES FOR SIERRA NEVADA CONSERVATION

The science team, with input from external science reviewers, determined the following major issues to be highest priority for national forest planning and management in the Sierra Nevada following the criteria described above (section *Science Team Approach and Organization of the Review).* Each issue is considered to be of urgent concern at broad geographic scales (wider than several national forests) and requiring a common conception and coordinated approach to problem analysis and evaluation, planning, and monitoring. Appropriate scales of implementation vary with the topic. Most of the topics highlighted pertain primarily to conditions of national forest lands and uses managed by national forests. Some issues of institutional behavior or of adjacent ecosystems are emphasized, however, because of their likely influence on national forest lands and resources or their demands on national forest staff. These are included as a recognition that national forest management benefits by taking a broad and integrated view of ecosystems rather than focusing on administrative boundaries alone. Issues that relate to adjacent lands or that affect institutional behavior may greatly affect implementation of national forest conservation plans, and in some cases may even determine the outcomes and likelihood of achieving goals, a topic which is addressed in a latter section of this report.

PRIORITY ISSUES FOR SIERRA NEVADA CONSERVATION

Issue: CULTURAL, DEMOGRAPHIC AND SOCIOECONOMIC CHANGES

Synopsis

* Attitudes, knowledge and values about the Sierra continue to change with regard to what people want from ecosystems there. Forest harvesting on public lands is losing support. Old forests are better understood and valued. Water is increasing in value to both agricultural and urban users. Wild rivers are more valued now than they were when post-World-War II urbanization was demanding more and more dams. Agencies and the public are recognizing that ecosystems change naturally and the fabled "balance of nature" may be elusive. Valued species are a part of ecosystem change. The public is becoming aware of the difficulty of distinguishing human influences on natural processes. However, there appears to be strong support for science that will explain the complex human role in Sierra Nevada ecosystems. This role includes the influence humans have on ecosystem structure and function and the influence ecosystems have on humans. There is recognition that these interactions operate as continual feedback loops, i.e. humans influence an ecosystem; it reacts; humans react to that change by intervening again, etc.

* In many parts of the Sierra Nevada, there is a shift away from raw material extraction towards a socioeconomic mix of recreation, education, land development, retirement, and computer technology. In some regions, like the northern Sierra, there remains a primary dependency on forest harvesting. The trend away from forest harvesting on public lands has had a major impact on the forest products industry in California and on the families and organizations (e.g. schools, county services) that relied on income from national forest harvesting. As this shift continues, pockets of serious poverty persist in the Sierra while, in other places (e.g. Nevada City - Grass Valley) land buyers are moving significant amounts of equity to these locales from the sale of their homes and businesses in metropolitan areas. These settlers bring attitudes and values developed originally in urban areas and which often conflict with traditional rural values and which have an increasing influence on land use decisions for private lands adjacent to the national forests and on the national forests themselves. The Lake Tahoe Basin is a microcosm of the wide range of wealth existing in the Sierra Nevada. In this watershed, many homes and families exist near the poverty line in close proximity to hundreds of multimillion dollar second homes.

* Population and economic growth in the Central Valley and on the western and eastern borders of Sierra Nevada national forests are changing the form and intensity of use within the forests and the goods and services that can be generated from national forest ecosystems. Employers are locating on the edges of Central Valley cities, and numbers of their employees are choosing to live adjacent to the national forests. These commuters, together with new noncommuting retirees and members of new Sierra Nevada businesses have become potential collaborators and constituents of national forests. They are bringing new skills and attitudes to the forums on land use planning. Many have advanced understanding of computers, telecommunications, and geographic information systems. They can now, or have the potential to, grasp the complexity and uncertainty of resource systems, and can become sophisticated technical colleagues to the understaffed national forests which are confronted with the mandate to develop conceptual models and conduct advanced and complex monitoring programs.

* Increasing recreation use and changes in recreation behavior patterns, with associated development in recreation technology (e.g. sports utility vehicles, all-terrain vehicles, mountain bikes, hang gliders, personal watercraft, high-speed/high-noise motorboats, ski areas), are bringing about changes in biophysical processes, scenic and aesthetic attributes, human monetary and recreational rewards, and shifting land use management challenges within federal and nonfederal agencies. Many of these recreation uses are in conflict with one another. Some are likely to bring about irreversible change to ecosystem structure and/or function. Knowledge about these environmental impacts, and an understanding of conflicts with other national forest uses, has not kept up with the development and use of recreation technologies. With ample access to most parts of the Sierra Nevada provided by these technologies, managers are challenged by the broad spatial scale of potential long-term impacts from a rapidly growing population employing an array of new recreational technologies in new ways. Many of the new patterns derive from the growing ethnic diversity of the California and Nevada populations, a diversity that brings new ways of recreating and forces new challenges on the national forests to accommodate these.

* A growing, more diverse, and wealthier population near the Sierra Nevada, one having easy access to the mountains, brings an array of controversy. Federal land agencies are required to establish formal relations with tribal governments. Federal, state, and tribal mandates and authorities often overlap on the same piece of ground, providing both a source of tension and an opportunity for engagement and collaboration. In the ethnically diverse state of California, multicultural awareness and appreciation are becoming formal institutional and agency goals. This is nurturing the recognition of the diversity of Native American cultures in the Sierra Nevada. Their histories are informing land managers about how to understand the evolving landscape and how to use human history as a source of appreciating the rich differences, and similarities, in culture-nature interactions over time.

* Land managers are being asked to anticipate cultural, demographic, and socioeconomic changes in choosing management strategies, in setting priorities, and in constructing collaborative arrangements for ecosystem and adaptive management. This requires planning across traditional jurisdictional boundaries and including management considerations for non-USFS lands, for example in the forest and forestry component of county general plans. This multijurisdictional cooperation is especially needed in the lower elevations of the western Sierra Nevada where oak woodlands, shrublands, and oak-conifer transitions are candidates for agricultural and urban conversion, where oak preservation, wild and prescribed fires, grazing, riparian modification, and wildlife management are factors requiring interagency cooperation. As experience is gained, the increased costs of multijurisdictional planning and management are coming to be recognized.

* Public and agency demands for more biophysical and socioeconomic information are increasing while research and project assessments (reviews and syntheses of existing knowledge) are clarifying the limits of knowledge and the complexities of ecosystems. The demand for better science, increasing knowledge and the recognition of limits to our understanding combine to produce unfulfilled expectations, conflicts, and shifts in land management strategies, but are providing, at the same time, new educational opportunities for formal and informal learning organizations that have the potential for bringing scientists, managers, and the public together in productive, long-term, adaptive management activities.

* New concepts and methods of ecosystem management, public and agency collaboration, science-management cooperation, environmental justice, and adaptive management are being developed and tested in the national forest system and in cooperating land-management agencies. These concepts require institutional investment and modification and have implications for the well-being of Sierra Nevada communities and the dispersed and distant Sierra Nevada communities of interest. They are costly, and the benefits to humans and nature are not yet fully discovered. Thus, there is skepticism in many institutional, agency, and public quarters. This skepticism is undermining adequate testing of these new concepts and approaches.

Recognition of the probabilities of extended Sierra Nevada drought, combined with high rates of statewide population growth, pending dam relicensing, and considerations of water revenues for Sierra Nevada watershed reinvestment, all foster potential conflicts over the role of water storage in the Sierra, water pricing and allocation, institutional power and authority, and population growth management.

* Settlement patterns and shifts in socioeconomics are creating new regions within and near the Sierra Nevada that govern the flux of people, money, power, and knowledge. This regionalization produces a dynamic network that must be identified, understood, and considered in attempts to manage Sierra Nevada ecosystems. In addition, where there was once a single federal agency regulating stewardship, there are now several. Making this change more complex is the growth of local power in the Sierra and of state power in California. This is changing and complicating policy tensions among national, state, and local interests and making collaboration a more challenging goal.

* There is a growing recognition that users of the Sierra Nevada must pay the true cost of that use. This recognition applies to grazing, logging, recreation and water, as well as to all other uses. In some cases, the true cost may be discernible, but in others the cost is elusive, especially when factoring in long-term and cumulative environmental impacts or social change. In many areas, it is believed that recreation, grazing, logging, and water are underpriced and offer an opportunity for reinvestment. At minimum, it appears that a more sophisticated means of establishing and recovering cost is required.

Additional References: Carpenter and Kennedy 1988, Cortner et al. 1995, Doak and Kusel 1996, Duane 1996a, Duane 1996b, FAC 1997, Grumbine 1991, Gunderson et al. 1995, Hoffman and Fortmann 1996, Holling and Meffe 1996, Kennedy and Mincolla 1982, Kusel 1996a; 1996b, Kusel et al. 1996, Larson 1996, Millar 1996, Mohai 1995, Nechodom and Greenwood 1998, Nechodom and Kusel 1998, North 1990, Reynolds 1996, Ruth 1996, Ruth and Standiford 1994, Sabatier et al. 1995, SPDR 1997, SNEP 1996 Vol. I, Starrs 1996, Starrs and Wright 1995, Stewart 1996, USDA Forest Service 1995, Wondolleck 1988, Wondolleck and Yaffee 1994, Wondolleck et al. 1996, Yaffee 1994.

Basis for Inclusion

* Social, economic, demographic, and institutional factors in the Sierra Nevada are widely regarded as governing the effective achievement of ecosystem management goals.

Geographic Region of Concern

* Sierra-Nevada-wide.

Primary Scales for Conservation

* Planning from local to national levels; implementation at all scales.

Relationship with National Forest Management

A. Reference above Synopsis:

* Demographic and socioeconomic change affecting Sierra Nevada national forests needs to be more fully articulated, documented, and examined so that these forces can become carefully considered factors in planning and management.

* Forest Service institutional behavior requires scrutiny to determine the benefits and costs of each new concept, innovation, or policy relative to priorities and objectives.

* Institutional evolution provides an opportunity to learn ways of going beyond the rhetoric and engaging organizational collaborators and the public in adaptive management, of viewing people as internal to the solution rather than as an external "species" to be managed.

* Coordinated and collaborative resource management (e.g., Coordinated Resource Management Programs, Quincy Library Groups, Mono County Coordinated Planning, Forest Protection Campaign, Lake Tahoe collaboration, etc.) need to be evaluated for a better understanding of the opportunities.

* Institutional innovation such as enterprise team and fee demonstration programs should be evaluated in the context of Sierra Nevada issues and opportunities.

* Service-wide risk-taking, adaptive organizations, creativity and innovation, and nontraditional experiments in workplace behavior should become part of the array of options.

PRIORITY ISSUES FOR SIERRA NEVADA CONSERVATION

Issue FIRE AND FUELS

Synopsis

* Fire is an evolutionary force that has shaped most low- to mid-elevation Sierra Nevada vegetated ecosystems for millennia. Prior to 1850, fires were generally frequent and mostly of low to moderate intensity from lower elevation blue oak woodlands through upper montane red fir. During the 20th century, combined effects of fire suppression, forest clearing, logging, grazing, and climate change contributed to highly altered fire regimes and associated ecosystems (Chang 1996, McKelvey et al. 1996, Skinner and Chang 1996).

* Tree-ring studies suggest that before the 1900s, fire frequency was positively associated with temperature; i.e., more frequent fires during warm periods and less frequent during cool periods. Thus, the 20th century experience of decreasing fire frequency (the result of fire suppression) with increasing temperature is contrary to historical trends. The primary effect of moisture, historically, was to affect the pattern of within-year synchronization of fires across landscapes. Dry periods appear to have been characterized by less synchrony of fires, whereas moist periods were characterized by more synchronization of fires across broad landscapes. These patterns are believed to relate to availability of fuel (e.g., less abundant vegetation during dry periods and greater abundance during moist periods). (Summarized from Swetnam 1993, Stine 1996.)

* Vegetative diversity of historic Sierra Nevada ecosystems was likely to have been enhanced by variation in fire-return intervals and fire severity patterns expressed spatially and temporally from stand to landscape scales. The variation within vegetation types appears to have been as great as the variation among types. The variation in fire-return intervals was probably as important as median or mean intervals as an influence on vegetative composition. Even if frequent fires of mostly low severity were restored to much of the Sierra Nevada, inadequate consideration for variation in fire-return intervals would likely lead to less than historical levels of vegetative diversity. (Summarized from Agee 1993, Chang 1996, Fites-Kaufmann 1997b, Fites-Kaufmann 1997a, Martin and Sapsis 1992, Sapsis and Martin 1994, Skinner and Chang 1996, Taylor and Skinner in press.)

* The current and immediately foreseeable smoke production from wildland fires (including potential increases in the use of prescribed fire) is greatly reduced from that likely to have been produced by pre-1850 fire regimes under which Sierra Nevada ecosystems developed (Cahill et al. 1996, Leehouts 1998).

* Wildland fires, in fire-adapted ecosystems, appear to have a negligible net effect on atmospheric greenhouse gas emissions as most of the carbon lost by burning is recovered by subsequent new growth (Leehouts 1998).

* Wildland fires before 1850 may have affected climate in two important ways: (1) as an effective sink for atmospheric carbon through production of charcoal that was stored in soils and sediments for centuries, and (2) through the production of atmospheric aerosols that contributed

to reduced temperatures by increasing backscattering of incoming solar radiation (Leehouts 1998).

* Despite these trends, there is evidence that a proportion of patches in most forest types by chance avoided burning for long periods. Fuel loads in these areas would likely have accumulated in greater abundance than in patches where fires burned more regularly (Fites-Kaufmann 1997a).

* There are many known ecological functions of fire. Mechanically manipulating vegetation may mimic the results of fires on the structural patterns of woody vegetation. However, there exists little information about the ability of nonfire vegetation treatments to mimic other ecological functions of fire. (Summarized from Chang 1996, SNEP 1996 Vol. I, Weatherspoon and Skinner in press.)

* Native Americans are known to have used fire to favor desired multiple resources in many Sierra Nevada ecosystems. The best documentation for this is in oak woodlands, ponderosa pine, and mixed-conifer types of the westside. This burning was likely to have decreased, at least locally, the median fire-return intervals by several years, producing associated ecological effects. (Summarized from Anderson 1997, Anderson and Moratto 1996, Anderson et al. 1997, Skinner and Chang 1996.)

* Fire suppression has been most effective at reducing area burned by fires under low- and moderate-intensity conditions. It has not been effective in reducing area burned under extreme fire-intensity conditions. The likely effect has been a shift in the proportion of areas burned by fires of varying intensities (McKelvey et al. 1996, Skinner and Chang 1996). For the 20th century, however, no single pattern of frequency and overall fire exists for all parts of the Sierra Nevada (Erman and Jones 1996, McKelvey et al. 1996).

* Live and dead fuels are more abundant and continuous in fire-adapted ecosystems of the Sierra Nevada at present than a century ago. This results from the combined effects of fire suppression, natural climate change, grazing, land disturbance from historic mining, logging, land clearing, and development (McKelvey et al. 1996, SNEP 1996 Vol. I, Weatherspoon and Skinner 1996).

* Fire suppression during the 20th century has favored an increased density of young trees throughout mid- to high-elevations in the Sierra and will likely continue to contribute to rapid accumulation of fuels (McKelvey et al. 1996, Skinner and Chang 1996). The increased growth of young trees has probably been exacerbated by climate change (i.e., increased moisture accompanied by increasing temperatures (Stine 1996, Woolfenden 1996, Millar et al. in review).

* Effectively managing fuel profiles over large landscapes to protect human and ecological values will require the development of broad-scale, landscape-level strategies. It is unlikely that a single prescription or method (e.g., fuelbreaks, prescribed fire, biomass harvesting, defensible fuel profile zones, etc.) will be successful in managing all landscapes across the range of the Sierra Nevada (no "one size fits all"). The development of effective strategies will require evaluation of the spatial patterns of vegetation/fuel conditions on expected fire behavior with and without proposed treatments across landscapes in relation to values at risk. The silvicultural methods proposed to achieve selected spatial patterns will also require evaluation of their efficiency and

effectiveness as well as potential impacts on other resource values. (Summarized from Finney et al. in press, Sessions et al. 1997, Weatherspoon 1996, Weatherspoon and Skinner 1996.)

* Timber and biomass harvest, including the salvage of dead and dying trees, affects fire hazard by changing local microclimates and modifying quantities and distribution of live and dead fuels. Historic (ca. pre-1960) timber harvest, which generally lacked adequate fuels treatment, increased potential fire severity, often greatly. In contrast, harvesting that interrupts fuel ladders by thinning small trees, combined with adequate treatment of surface logging residues and other fuels, can substantially reduce the probability of severe fires. (Summarized from Stephens 1998, van Wagtendonk 1996, Weatherspoon 1996.)

* Intermixed urban development in fire types of the west slope and scattered areas elsewhere poses increased exposure of life and property to wildfire, creating high demand for suppression resources away from wildland areas (a "suppression sink" for firefighting) during large fire situations (Husari and McKelvey 1996).

* The area burned by human-caused fires has generally exceeded that of lightning-caused fires throughout the 1900s, although in the last three decades the relative area burned by lightning-caused fires has increased (Weatherspoon and Skinner 1996).

* Firefighting resources have been steadily declining since the mid-1970s while emerging social, economic, and biological factors make all aspects of fire management more costly (Husari and McKelvey 1996).

Additional References: Agee 1993, Andrew 1994, Arno 1994, Bahro 1993, Beesley 1996, Bekker 1996, Blackburn and Anderson 1993, California Board of Forestry 1996, Caprio and Swetnam 1995, CDF 1995,Caprio et al. 1994, Elliott-Fisk et al. 1996, Elliott-Fisk et al. 1997, Green et al. 1997, Helms and Tappeneiner 1996, Husari and Hawk 1994, Keeley 1995, Keifer 1995, Keifer and Stanzler 1995, Laudenslayer and Skinner 1995, Lewis 1993, McKelvey and Busse 1996, Millar 1996, Millar 1997, Minnich et al. 1995, Mutch 1994, Murphy 1996, Omi 1996, Parsons 1995, Parsons and Botti 1996, Potter 1994, Rice 1993, Sapsis et al. 1996, Schmidt 1995, Skinner and Weatherspoon 1996, Solem 1995, Stephens 1995, Stephenson 1994, Stewart 1996, Taylor 1993, Taylor 1995; 1995b, Toth et al. 1994, USDA Forest Service 1995.

Basis for Inclusion

* Most upland and riparian vegetation in the Sierra Nevada below subalpine evolved with and are highly adapted to regular fire. Suppression has altered fire regimes, removed the evolutionary force, and/or created fire conditions that are very different from those of natural ecosystems.

* Human- and nonhuman-caused fuels are high throughout fire-adapted forest, shrub, and range types in the Sierra Nevada, posing significant threats to human life and property, species habitat and socially valued ecosystems from catastrophic wildfires.

* Urban intermix has increased dramatically, creating high demand for suppression activities and drawing suppression resources away from fighting fire in valued wildland areas.

* Smoke from fires (both planned and unplanned) is recognized as being harmful to human health. The degree of potential harm is related to intensity and duration of exposure (Black 1997, Cahill et al. 1996).

Geographic Region of Concern

Range distributions of fire-adapted vegetation types (not intended to imply areas targeted for specific treatments):

* Western Sierra: true fir types, mixed conifer, pine, oak woodlands, cypress, chaparral, and grassland types.

* Eastern Sierra: eastside pine, eastside mixed conifer, lodgepole pine, pinyon/juniper, sagebrush steppe.

Primary Scales for Consideration

* Fire is a broad-scale process, potentially affecting tens of thousands of acres in a single event. Effective management of fire requires development of broad-scale strategies that may require cooperation among several agencies and property owners.

* Management scale is linked to the institutional scale of cooperation (California Board of Forestry 1996).

* Urgency is rangewide for:

• Landscapes containing areas of human health, safety, property, and cultural values; this emphasizes the urban intermix zones of the west slope, Lake Tahoe Basin, and perimeters of other communities, and areas of high cultural heritage values.

• Landscape zones of high resource value, especially the range of the California Spotted Owl, forest carnivores, northern goshawks, and other Threatened, Endangered, and Sensitive plant and animal species habitat, rangewide riparian ecosystems, rangewide old-forest ecosystems, and areas of high cultural heritage values.

* Development of landscape strategies is regional to local (within planning watersheds). Landscape priorities are determined by evaluation of combined fire risk, hazard, and values of resources (including urban settlement) being protected (e.g., Finney et al. in press, Sessions et al. 1996, Weatherspoon and Skinner 1996).

Relationship with National Forest Management

A. Reference above Synopsis:

* Effective landscape-scale strategies likely include consideration of many national forest resource concerns:

- Reintroduction of fire; management fires;
- Fuel-reduction projects and maintenance of fuel-reduction projects;
- Hazards and risks associated with unplanned fires;
- Air quality and effects on human health of both planned and unplanned fires;
- Replaceability of fire effects during non-fire fuel treatments;
- Urban intermix;
- Threatened, Endangered, and Sensitive species conservation;
- Maintenance/management of suppression forces;
- Interagency coordination of fire suppression and firefighting;
- Slash treatment postharvest.

B. Reference other issues in this report:

How might the following be integrated in multi-forest and bioregional planning?

- Riparian, owl/forest carnivore/Threatened, Endangered, Sensitive species habitat, and old-forest ecosystem management [See Issues on CALIFORNIA SPOTTED OWL, FOREST CARNIVORES];
- Old-forest ecosystem management [See Issue on OLD FORESTS];
- Riparian management [See Issues on AQUATIC, RIPARIAN, AND MEADOW ECOSYSTEMS, LOW- TO MID-ELEVATIONS AND HIGH ELEVATIONS].

PRIORITY ISSUES FOR SIERRA NEVADA CONSERVATION

Issue: OLD-FOREST ECOSYSTEMS: (1) FOREST CONDITIONS OF STRUCTURALLY COMPLEX FOREST TYPES

Synopsis

* Sierra Nevada old forests are discrete ecosystems endemic to the Sierra Nevada. Prior to 1850, old-forest ecosystems of structurally complex conifer forest types occurred at multiple geographic scales ranging from individual trees (i.e., within stand or patch) to stands, and various sized landscape units. Original Sierra Nevada old forests appear to have existed as interconnected, heterogeneous landscape units that incorporated compositional, structural, and functional elements at many scales. (Summarized from Beardsley et al. in press, Bonnickson and Stone 1982, FAC 1997, Franklin and Fites 1996, Franklin et al. 1997, Fites-Kaufmann 1997a, Taylor and Halpern 1991.)

* Large trees are ecologically important structural attributes both within and outside late-successional stands (Graber 1996). For instance, 97% of the habitat patches in which owls roosted contained residual large trees (^{3} 40 inches diameter at breast height [dbh], Moen and Gutierrez 1997). Current national forest classification procedures generally fail to detect this residual tree component (Moen and Gutierrez 1997). The actual diameter that makes large trees ecologically significant varies depending on wildlife use, forest type, latitude, elevation, slope and aspect, surrounding forest matrix, and relation to ranges of wildlife and plant species.

* Diversity of pre-1850 old-forest patches appears to have been very high, both within and among patches, creating landscapes that were mosaics of high heterogeneity (Franklin and Fites 1996). Little direct information is obtainable about pre-1850 distribution or abundance of patch types within and among landscapes, but low diversity (e.g., even-age) and early seral patches certainly occurred within late-successional landscapes resulting from areas of higher intensity fire (Bekker 1996, Bonnicksen and Stone 1981; 1982, Chang 1996, Stephenson et al. 1991, Taylor and Halpern 1991, Solem 1995, Stephenson 1994, Stephenson et al. 1991, Skinner and Chang 1996, Taylor and Halpern 1991, Taylor and Skinner in press). High variability across the landscape appears to have been a combined result of fire regime and history, insect and pathogen activity, climate history, soils, Native American influence, and position in the landscape (Fites-Kaufmann 1997a, Fites-Kaufmann 1997b, Taylor and Skinner in press).

* Fire was a key environmental process influencing the development of old-forest conditions before fire suppression. The summer-dry, Mediterranean climate of the Sierra Nevada ensured that, when fuels were available, conditions usually existed to promote the spread of fire. The frequent fires, their behavior influenced by landforms/topography, weather conditions, and patterns of previous burns, influenced the development of old forests within a mosaic of heterogeneous forest conditions across broad landscapes. (Summarized from Fites-Kaufmann 1997a, Skinner and Chang 1996, Taylor and Skinner in press.)

* Some controversy exists over pre-fire suppression forest conditions partially due to different interpretations of the writings/diaries of early settlers. However, while being an important part of recent history, early descriptions of vegetation conditions, without associated photographs,

quantitative data, or maps showing extent of the area being described are problematic to assess. The use of many descriptive terms (e.g., "open", "closed", "dark", "dense", "widely spaced", etc.) are relative to the experiences of those writing at the time, and may not be representative of conditions under which these same terms would be used today (Skinner 1997, SNEP 1996, Vol. I).

* Recent landscape-level, tree-ring studies that assessed the apparent variation in fire frequency (Fites-Kaufmann 1997a, Taylor and Skinner in press) and patterns of severity across landscapes (Taylor and Skinner in press), along with knowledge of current fire behavior, suggest that forests with more late-successional characteristics (e.g., species composition, canopy cover, multi-layered canopy, higher density of large diameter trees, snags, coarse woody debris) historically were more likely to be found at lower slope positions as well as on north- and east-facing slopes within a local topography. In response to generally more severe fire, upper slope positions as well as intermediate positions on south- and west-facing slopes were more likely to display a pattern of scattered, remnant, older trees and patches within a coarser-grained pattern largely of younger stands (Taylor and Skinner in press).

* Considerable uncertainty exists regarding the long-term historical range of attributes and modal characteristics associated with old forests under fully functioning fire regimes. Current descriptions of old forests may not be representative of the long-term, historical range of conditions in pre-1850 forests or native forests (Chang 1996, McKelvey et al. 1996, Skinner and Chang 1996, Thornburgh 1995).

* Four percent (18 species) of Sierra Nevada vertebrates depend on old forest ecosystems; 24% of these are at risk; 51 species use old forests but are not dependent on them (Graber 1996). For many of these, information is inadequate to determine whether the species require old forest ecosystems or simply the presence of certain old forest attributes such as some minimum density of big trees, snags and logs, and a certain canopy cover (Graber 1996, Graber, pers. comm.). Studies of old-forest-associated species (e.g., forest carnivores) suggest that home ranges are in large block sizes (Banci 1994). Late-successional forests are recognized as one of three Sierra Nevada ecosystems having suffered greatest reductions in extent and integrity and in losses to biodiversity (Graber 1996). See Issues on CALIFORNIA SPOTTED OWLS AND FOREST CARNIVORES.

* Long-term reductions in the number of large trees and the area of late seral/old forest in the Sierra Nevada, combined with changes in forest structure through timber harvest and fire suppression (McKelvey and Johnston 1992, Franklin and Fites-Kaufmann 1996) have likely reduced the amount of nesting and foraging habitat for northern goshawks (*Accipiter gentilis*), but reliable data on population trends are not available (Keane, pers. comm.) Goshawk nesting habitat varies among vegetation types but, within any given type, nesting stands consistently have higher densities of large trees and higher canopy cover than randomly selected stands in the same vegetation type (Squires and Reynolds 1997). Goshawks also have large area requirements (home ranges in the Lake Tahoe area = 2020-15,500 acres in the breeding period and 3500-37,150 acres in the nonbreeding period [Keane, pers. comm.]).

* Annual reproduction by northern goshawks varies markedly, and 30-90% of territories produce young, depending on conditions each year. This is probably determined primarily by

variation in the availability of Douglas squirrel (*Tamiasciurus douglasii*), a primary prey species. Variation in squirrel abundance appears to be driven mainly by variability in cone-crop production. Temperature and precipitation apparently interact with squirrel abundance to influence goshawk reproductive success (summarized from Keane, pers. comm.).

* Cone production differs by tree size-classes and tree species, with large, mature conifers generally producing cones more frequently , and with much larger crops, than smaller, younger trees (Fowells and Schubert 1956).

* Authors use different definitions for Sierra Nevada old forests depending on what they are studying or emphasizing; these yield varying descriptions, inventories, assessments, and recommendations for management. Differences relate to whether these ecosystems are viewed primarily as wildlife habitat or as vegetation communities, or to what geographic scale is considered important (see section on "Issues for Further Clarification" and Appendix I, Part 1). Similarities among definitions include large and old trees.

* Structural complexity evaluations of old forest from SNEP (delineations based on specialists using diverse imagery and map sources and criteria, Franklin and Fites 1996) indicate an average of 14% late-successional/old-growth (landscape units [polygons] ranked as "4s and 5s") forest exists overall in the Sierra Nevada at present, ranging from 0% in foothill pine/oak to 30% in red fir. National forests on average have 9% polygons ranked 4 and 5, whereas national parks have 21% (Franklin & Fites 1996).

* Structural complexity classes mapped by SNEP focus on landscape pattern and identification of larger areas of late-successional forest for delineation (Franklin and Fites 1996); a database of attributes for patches within landscape units (polygons) was also developed although these units are not mapped. Two efforts to validate this mapping were done: structural complexity classes had considerable variability when validated by ground surveys; based on limited sampling in parts of the range with plots 0.2 acre in size and a diversity of variables, classification accuracy averaged about 60% overall and 44% for LS/OG ranks 4 and 5 (Langley 1996). Structural complexity classes had considerably higher accuracy when compared to modeling efforts (based on a simulation for the Eldorado National Forest), which used similar criteria to the mapping effort (Sessions et al. 1997). Mapper's estimates exceeded the modeler's estimates by 0.5 to 1.0 rank in 16% of the late-successional polygons. In another comparison, modeled ranks were more tightly distributed around the middle classes than those determined by mappers, and modeled ranks lacked the later successional classes compared to the mapper's (Sessions et al. 1997). Differences in the two efforts are likely based on variables chosen for analysis, which serves to underscore the significance of definitions and scales used to describe and measure old-forest elements.

* Thematic mapper evaluations (of Sierra Biodiversity Institute, evaluated in Davis 1996) estimate an overall average of 13% LS/OG in the Sierra Nevada, similar to the value from structural complexity methods (Franklin and Fites 1996). There is only modest overlap, however, between the two methods in location of late seral forest. The association of mapped LS/OG polygons between Franklin and Fites (1996) and Sierra Biodiversity Institute (in Davis 1996) is very low for Jeffrey pine, eastside pine, white fir, white fir/pine; positive but low for red fir; and

moderate for mixed-conifer forests, although amounts of old forest calculated for mixed conifer differed by the two methods.

* Beardsley et al. (in press) used ground plot information on structural and compositional diversity from the Forest Inventory and Analysis program to inventory old forests in Sierra Nevada national forests. This approach focused on a set of structural and compositional attributes measured in 5-10-point cluster plots ranging from 2.5 to 5 acres in size. They found an overall average of 15% LS/OG (based on total conifer forest) in the Sierra Nevada, ranging from 5% on the Plumas National Forest to 38% on the Lake Tahoe Basin Management Unit. About 4% of the average 15% LS/OG was in reserved lands. Sixty-five percent of the forest in the combined national parks (Lassen, Yosemite, Sequoia/Kings Canyon) was late successional.

* Present forests differ from pre-1850 most significantly by:
  • reduction of large trees and structural diversity within patches (local homogenization);
  • loss of diversity among patches (landscape homogenization and simplification);
  • loss of continuity and distribution of old forests across the landscape (landscape gaps).

Clear-cutting timber practices, indiscriminate burning in the 1800s, and fire suppression led primarily to these losses in old forest diversity. (Summarized from Chang 1996, Franklin and Fites 1996, Skinner and Chang 1996, Taylor and Skinner in press).

* Accumulation of dead woody material: Consistent with patterns expected in a region influenced by a summer-dry Mediterranean climate, fire-history studies have shown that most pre-1850 fires occurred during late summer and early fall when fuel moistures are generally low (Bekker 1996, Caprio and Swetnam 1995, Norman and Taylor in press, Taylor 1995a, Taylor 1998, Taylor and Skinner in press). This suggests, along with knowledge of past fire frequencies and current fire behavior, that current accumulations of dead woody material are likely in excess of pre-1850 levels as a result of fire suppression (Chang 1996, McKelvey et al. 1996, Thornburgh 1995, Weatherspoon and Skinner 1996).

* Sugar pine (*Pinus lambertiana*) and other white pines (*Pinus* subsection *Strobus*) are at high risk from the spreading epidemic of fatal white pine blister rust caused by alien *Cronartium ribicola*. Maintenance of large trees, regardless of genetic susceptibility, is considered critically important for the species to persist through the epidemic (Millar et al. 1996).

* Loss of density of large-diameter trees along with an increased density of smaller-diameter trees has occurred in unlogged stands over the period of fire suppression. Many have hypothesized that the loss of larger trees has been at least partly due to the increased competition from the smaller trees. This has likely created stressful conditions for larger trees leaving them more susceptible to insect attack during droughts. Higher levels of competition have also reduced growth of remaining trees so that larger diameter trees are less likely to be recruited into stands (Dolph et al. 1995, Minnich et al. 1995).

* Evaluation of 10 different proposed and actual management strategies that address old forest concerns found none to be ideal from the standpoint of critical old-forest design criteria. The two "LS/OG" strategies (Franklin and Fites 1996 Area of Late Successional Emphasis [ALSE] and

derivative) came closest to addressing all of the important ecological elements (Franklin et al. 1997).

* A simulation modeling analysis of 10 alternative forest management strategies indicated that, in applications to the Eldorado and Plumas National Forests, late-successional forests can be rebuilt over the time periods of the simulations (50 years) following the "LS/OG, ALSE" strategy (Franklin and Fites 1996) while at the same time reducing susceptibility of severe fires. Other strategies, except a no action strategy, also rebuilt late successional forests to high levels over the simulation period (Johnson et al. 1997).

Additional References: Austin 1993, Beier and Drennan 1997, Bloom et al. 1986, Bright-Smith and Mannan 1994, California Department of Fish and Game 1994, Davis 1996, Davis and Stoms 1996, Garrison 1994; 1996, Hargis et al. 1994, Potter 1994, Reynolds et al. 1992, Spies 1997, Toth et al. 1994, USDA Forest Service 1995, USDA 1994, USDA Forest Service 1995, USDA Forest Service 1996, Woodbridge and Dietrich 1994, Zielinski et al. 1995a, 1995b.

Basis for Inclusion

* Old forests are unique ecosystems in the Sierra, support critical habitat for dependent flora and fauna, provide ecosystem services, and have high social value.

* Despite differences in interpretation, all estimates indicate that the abundance of old forests and the structural complexity of remaining low- to mid-elevation forests in the Sierra Nevada have declined significantly since post-1850 settlement, to the detriment of associated species and ecosystem functions. Additionally, fire regimes have been highly altered in the 20th century, likely leading to alterations in development patterns of old-forest ecosystems. Old forests of the Sierra, including foothill and riparian types, are highlighted as ecosystems deserving highest priority for restoration.

* National forest management directly and significantly affects the quality and quantity of old-forest ecosystems.

Geographic Region of Concern

* Rangewide distribution of high-concern forest types: mixed conifer (east- and westside), true fir, Jeffrey and ponderosa pine types, and western foothill types, all including associated riparian elements.

Primary Scales for Consideration

* Rangewide extent of individual forest types: westside mixed conifer, true fir, ponderosa pine, eastside pine, eastside mixed conifer (pine/fir).

* Local to rangewide scales, emphasizing stand, meso-scale units, and landscape scales equally.

* Microhabitat elements (especially mature to late-seral conifers, periodically "bumper" years of cone production, relatively high canopy) individual home ranges, and larger landscapes with multiple goshawk territories.

Relationship with National Forest Management

A. Reference above Synopsis:

* Do current national forest plans adequately emphasize maintenance and restoration of structural complexity within stands and inter-stand diversity?

* Does adequate spatially explicit information exist to evaluate and plan landscape-scale networks and interconnectivity of late-successional stands and landscape units?

* How does management of old-forest ecosystems contribute to the distribution and abundance of northern goshawk habitat throughout the Sierra Nevada, particularly large trees and mature/late-seral/old-forest stands occurring in the matrix between the late-successional landscapes?

* How will future forest management affect the spatial and temporal distribution of northern goshawk nest habitat, foraging habitat, the distribution of key prey species such as the Douglas squirrel?

* In what ways can management assure the maintenance of the natural pattern of annual variability in cone production among conifers in all forest types used by goshawks in the Sierra Nevada?

B. Reference other issues in this report:

To what extent can spatially explicit modeling and management of old-forest ecosystems provide for the needs of California spotted owls and forest carnivores? How could wildlife plans be altered to address maintenance and recruitment of large trees, including "legacy" and "residual" trees and other elements of structural complexity within high-quality, late-successional stands and in matrix forests? [See Issue on CALIFORNIA SPOTTED OWLS, FOREST CARNIVORES, and other old-forest associated species.]

* What landscape strategies could reduce the likelihood of large, severe fires while providing long-term, late-successional conditions that incorporate or recognize the important relationships to pre-1850s patterns? [See Issue on FIRE and FUELS.]

* How might improved evaluation of late-successional characteristics help to incorporate the influence of fire as an ecological process? [See Issue on FIRE and FUELS.]

* What trade-offs exist among deterimental effects of roads on habitat fragmentation and disruption versus beneficial effects on fire protection? How might these pros and cons be evaluated? [See Issue on ROADS.]

PRIORITY ISSUES FOR SIERRA NEVADA CONSERVATION

Issue: OLD-FOREST ECOSYSTEMS: (2) CALIFORNIA SPOTTED OWL (*Strix occidentalis*)

Synopsis

* Analysis by Bart (1995) of the relation between the proportion of a pair's home range that is in suitable habitat and the productivity and survivorship of northern spotted owls "...suggests that removing any suitable habitat within the vicinity of the nest tends to reduce the productivity and survivorship of the resident owls." Assuming that these relations are valid for California spotted owls in the Sierra Nevada, "It appears that lambda [essentially the annual balance between birth rate and survival rate by age class on one hand, and mortality rate by age class on the other] is probably about 1.0 when suitable habitat covers 30%-50% of the landscape." That is, below some undetermined (*threshold*) level between 30% and 50% suitable (95% confidence interval) we should expect owl reproduction to fall below replacement rate. In the absence of clear reasons why these results would not apply to the California spotted owl as well, they need to be considered in planning for the owls in the Sierra Nevada.

* Assessment at a landscape scale could be based on the crude density of owls (expressed as the mean number of acres/owl over the entire landscape that has owls, including both suitable and unsuitable habitat). For example, the full demographic study area on the Sierra National Forest averages about one owl site for every 4 square miles. A circle with this area has a radius of 1.13 miles. If the threshold level for replacement is at, say 40% suitable, this circle would need to include at least 1024 acres of suitable habitat for some assurance of replacement-rate reproduction by an owl pair. If it is at 50%, the circle would need to include at least 1280 acres. Bart (1995) states that "...it should not be assumed that habitat in all ranges could be reduced to the minimum level without adverse effects on the population. If, initially, some home ranges had more than the required amount of habitat while others had less, and if habitat was removed until no home ranges had more than the needed amount, then obviously the average amount of habitat per home range would be less than the amount needed for population stability."

* All demographic study areas within the Sierra Nevada are now showing significant population declines. This was true on the Lassen National Forest for 1995, 1996, and 1997 (Zabel, pers. comm.), on the Eldorado National Forest for 1997 (Gutierrez, pers. comm.), on the Sierra National Forest for 1995, 1996, and 1997 (Steger, pers. comm.), and in Sequoia/Kings Canyon National Parks for 1996 and 1997 (Steger, pers. comm.).

* Since release of the California Spotted Owl Report (CASPO (Verner et al. 1992), additional owl sites have been located in the Sierra Nevada. Some of these may be superior to sites earlier designated for delineation of Protected Activity Centers (PACs) (Gould, pers. comm.).

* Not all pairs of California spotted owls nest every year. In fact, over the 8-10 years of demographic studies in the Sierra Nevada, only in 1992 did nearly all pairs under study nest. It is not unusual for owls in an established activity center to skip several years between one nesting and the next. In the demographic study on the Sierra National Forest, for example, the percentages of pairs nesting over the years of study were the following: 1990 - 63%, 1991 - 67%, 1992 - 90%, 1993 - 58%, 1994 - 58%, 1995 - 26%, 1996 - 24%, and 1997 - 34% (Table 7a in

Steger et al. 1997). Sites may even be vacant for several consecutive years when the population is in decline, but then be occupied and even support breeding pairs during an upswing in the population.

* The mean dbh of nest trees in Sierra conifer forests was about 45 inches (Verner et al. 1992), but the "oldness" of those trees was only inferred from their large diameters. Based on Region 5 data on known ages and diameters of conifers at least 39 inches in dbh (but not owl nest trees) from the seven westside national forests, mean tree ages in different timber strata ranged from 157 to 438 years, with an overall average of 258 years. "Most strata-level age estimates averaged between 250 and 300 years" (Verner and McKelvey 1994). Recorded ages of 22 conifer nest trees from the demographic study in the Sierra National Forest averaged 241 years (range = 82-335 years); six were less than 200 years old, four were 200-250 years old, seven were 251-300 years old, and five were older than 300 years (North, pers. comm.). Variability in dbh in relation to age was high, probably in part because the mix of trees sampled came from a variety of site conditions, slopes, aspects, etc. A regression of age against dbh in this sample was not statistically significant, ($R^2 = 0.18$; $0.10 > P > 0.05$), so it is safer to measure age directly from nest trees, rather than relying on dbh as an index of age.

* Twentieth century fire records at a broad, Sierra Nevada scale show that fire risk, or the chance of having a fire, is inversely related to elevation (McKelvey and Busse 1996). At the landscape or watershed scale, however, fire-severity patterns have been found to be related to history of logging and fuel treatments, topography, and forest type (Weatherspoon and Skinner 1995). Reconstruction of fire-severity patterns over longer time spans, based on tree-ring studies, suggests that the more severe fire patches were found on upper slopes, ridges, and intermediate positions of south- and west-facing slopes. Less severe fire topographic positions were lower slopes, canyon bottoms, and intermediate positions of north- and east-facing slopes (Taylor and Skinner in press). These indicate differing risks and hazards for habitat with changes in elevation, topography, and forest condition.

Additional References: Moen and Gutierrez 1997.

<u>Basis for Inclusion</u>

* The California spotted owl is a Forest Service Sensitive Species in Region 5. It is known to be closely associated with older-forest attributes (large, old trees; large snags; large, downed logs). Because a recent effort failed to complete and implement a new, Regional EIS for the owl and other issues in national forests of the Sierra Nevada, the owl remains as a significant issue to be addressed in any new effort that would amend management practices in the Sierra Nevada national forests. Finally, the other two subspecies (northern spotted owl and Mexican spotted owl) have both been federally listed as threatened. Lacking a realistic effort soon to provide adequate protection for the California spotted owl, it may become federally listed as well.

<u>Geographic Region of Concern</u>

* That part of the Sierra Nevada bounded by limits of distribution of the California spotted owl.

<u>Primary Scales for Consideration</u>

* (Per first bullet in Synopsis) Microhabitat elements (especially very old trees, large snags, downed woody material, multilayered stands, and relatively closed canopies), individual home ranges, and larger landscapes with multiple owl sites.

* (Per remaining bullets in Synopsis) Entire Sierra Nevada range of suitable habitat.

Relationship with National Forest Management

A. Reference first six items in Synopsis, respectively:

* Are we providing landscapes with a sufficient proportion of suitable owl habitat on national forest lands to assure replacement-rate reproduction by the California spotted owl?

* In what ways might the recently established, statistically significant population declines in all demographic studies in the Sierra Nevada influence management standards and guidelines?

* Do opportunities exist to strengthen the network of PACs for the owls in the Sierra Nevada?

* Are we monitoring historical but unoccupied owl sites long enough to assure that they are not, in fact, suitable for owls?

* What density of trees exceeding 250 years of age is provided in Sierra conifer forests by current management, and how generally distributed are those trees?

* How would fire-risk ratings of owl sites, based on elevation, forest type, slope, and aspect influence selection of treatment areas and type of fuels treatments in the development of landscape strategies designed to reduce the likelihood of large, severe fires?

B. Reference other issues in this report:

* What is the significance for spotted owl management of the poor fit between existing LS/OG maps and the locations of suitable owl habitat? [See Issue on OLD-FOREST ECOSYSTEMS (1).]

* What is the significance of the failure of current National Forest stand classification systems to detect, and hence to consider in planning, "residual tree" components (trees ^{3} 40 inches in dbh and generally older than 200 years)? [See Issue on OLD-FOREST ECOSYSTEMS: (1), specifically in reference to article by Moen and Gutierrez 1997.]

* Might the prolonged duration of the interim guides result in unanticipated, negative impacts on the Spotted Owl? [See Issue on EFFECTS OF CALIFORNIA SPOTTED OWL (CASPO) INTERIM MANAGEMENT.]

* To what extent can spatially explicit modeling of the overlap in habitat needs of spotted owls and carnivores be shown to provide for the needs of northern goshawks as well? Stated in terms of the "umbrella" concept, would the maintenance of habitat attributes needed by northern

goshawks, when added to those maintained for spotted owls and carnivores, enlarge the array of plant and animal species protected in mature and older forests of the Sierra Nevada? [See Issue on OLD-FOREST ECOSYSTEMS: (1).]

PRIORITY ISSUES FOR SIERRA NEVADA CONSERVATION

Issue: OLD-FOREST ECOSYSTEMS: (3) FOREST CARNIVORES

Synopsis

* Fishers (*Martes pennanti*) appear to occupy less than half of their known historic range (1919-1929, Grinnell et al. 1937) range in the Sierra (Zielinski et al. 1995a, Zielinski et al. 1997b. Recent surveys indicate that animals are absent on the west, and probably east, side of the range north of Yosemite National Park. Moreover, annual mortality rates of adult females in the Sequoia National Forest study area appear to be relatively high (Truex et al. in review, Zielinski et al. 1997a). Fishers rest in large diameter conifers and hardwoods (Klug 1996, Ruggiero et al. 1994, Seglund 1995, Truex et al. in review, Zielinski et al. 1995b, Zielinski 1997a). Fishers in the eastern United States have responded favorably to moratoria on trapping and have rapidly reoccupied suitable habitat. This has not occurred in the Sierra Nevada, despite the absence of a trapping season since 1945, indicating that: (1) insufficient habitat exists for dispersing animals to found new populations, (2) extant populations are too small to produce sufficient dispersing animals to recolonize the vacant areas, or (3) dispersal habitat is of poor quality, or is interrupted by nonforest land uses and roads, and dispersing animals succumb or are killed during dispersal. In general mammals have more difficulty than spotted owls, goshawks, or other birds dispersing to vacant patches of habitat, which makes it more difficult for fishers (like other forest carnivores) to locate distant, suitable habitat. The most common opinion among scientists is that loss of structurally complex forest rangewide, the loss of well-distributed large conifers *and* hardwoods, and the fragmentation of habitat by roads and residential development are responsible for the loss of fishers from the central and northern Sierra *and* the failure of dispersing animals to recolonize the area. Although recent analyses have determined that roads are currently less common in the northern than central or southern Sierra Nevada (Davis and Stoms 1996) roads are more common throughout the Sierra Nevada today than historically, and are a source of mortality (Zielinski, pers. observ.) and a potential barrier for forest carnivores. This opinion will be tested by analyses now in progress of forest composition and pattern. What is clear, however, is that fishers are absent--or occur at extremely low numbers at best--in a large part of the Sierra Nevada and southern Cascades.

* American martens (*Martes americana*) occupy much of their known historic (1919-1929, Grinnell et al. 1937) range in the Sierra (Kucera et al. 1996, Zielinski et al. 1997b), but our understanding of their distribution is less precise than that for fishers. Marten association with mature and old-forest ecosystems (Buskirk and Powell 1994, Ruggiero et al. 1994) makes them vulnerable to loss of large trees and large patches of mature, high-elevation true-fir forest. The conservation of martens will require a better understanding of the current extent of fragmentation of true fir (*Abies* sp.) forests and sensitivity to additional fragmentation by management activities. Martens, like the fishers, occur in the Sierra at the southernmost portion of its North American range, and populations at the tip of this peninsula may be more vulnerable than those closer to the center of the species' range. Like many other carnivores, martens have relatively large home ranges for their body size and therefore occur at relatively low densities. The combination of relatively low, natural population sizes and association with habitat that is vulnerable to additional losses (old-forest conifer ecosystems) makes martens particularly vulnerable to activities that

decrease canopy closure or remove large-diameter standing and downed material from forest lands (Buskirk and Powell 1994, Ruggiero et al. 1994).

* The occurrence of wolverines (*Gulo gulo*) in the Sierra Nevada is based on unconfirmed sightings that are periodically reported (Kucera and Barrett 1993). Because wolverines are difficult to detect, the lack of verifiable information on their existence is not necessarily evidence of their absence. Too few surveys -- especially those specific to the detection of wolverines only -- have been done to conclude that they are extirpated from the Sierra Nevada or from California. In fact, recent unconfirmed detections in the southern Oregon Cascades (Copeland, pers. comm.) suggest that wolverines either still exist but have been undetected in the Sierra Nevada, or that this nearby population to the north could produce dispersers capable of reoccupying former range in California. Human recreation, both in summer and winter, in high-elevation habitats of wolverines will continue to discourage recolonization or expansion of wolverine populations in the Sierra (Ruggiero et al. 1994).

* Sierra Nevada red foxes (*Vulpes vulpes necator*), like wolverines, have not been verified to occur in California for some time. And, like wolverines, too few surveys for red foxes have been done at high elevations to ascertain their status. Red foxes recently detected, and subsequently radio-collared in the vicinity of Lassen National Park, need to be subjected to genetic evaluation to determine their identity (Kucera 1993, Kucera, pers. comm.). The lowland, alien subspecies of red fox is easily confused with the native subspecies, and evidence suggests that the former is increasing its distribution in the Sierra Nevada (Lewis et al. in press).

Additional References: Carroll 1997, Dark 1997, Graber 1996, Hargis and Bissonette 1997, Heinemeyer and Jones 1994, Krohn et al. 1997, Lewis and Zielinski 1996, Zielinski and Kucera 1995.

Basis for Inclusion

* Each of the forest carnivores, with the apparent exception of martens, has suffered significant declines in its range in the Sierra Nevada. Appropriate national forest management could lead to significant improvements in carnivore population distribution and stability. Fisher and wolverines have each been petitioned, at least once, to be listed under the federal Endangered Species Act. Fishers, martens, and Sierra Nevada red foxes are Forest Service Sensitive Species in the Sierra Nevada. Various forests have listed martens, fishers, wolverines and Sierra Nevada red foxes as Management Indicator Species. The state of California has listed wolverines and Sierra red foxes as Threatened and fishers as a Species of Special Concern.

Geographic Region of Concern

* Sierra Nevada rangewide, across the historic distribution of fishers, martens, wolverines, and Sierra Nevada red foxes.

Primary Scales for Consideration

* Microhabitat elements (especially wood and rock structures used as resting and denning sites).

* Home ranges.

* The portion of the southern Sierra currently occupied by a fisher population. (Potentially requiring management different from other areas).

* Entire Sierra Nevada within the ecologically meaningful, pre-1850 historic range of each species.

Relationship with National Forest Management

A. Reference above Synopsis:

* Adequate maps describing the vegetation cover types, and their structural and compositional attributes, throughout the Sierra Nevada.

* Guidelines for describing fisher and marten habitat in the Sierra, using improved vegetation maps.

* Development of Sierra-wide habitat suitability map for each species, based on improved vegetation maps.

* If habitat analyses suggest that the central and northern Sierra could support a fisher population, (1) Identification and management of special areas that serve best to direct dispersing animals to the area and (2) Consideration of translocating fishers as a means of repopulating the area.

* Assessment of the efficacy of current fisher/marten network (defined under Freel 1991); comparison of Freel approach with other approaches to fisher and marten conservation planning.

* Guidelines for assessing potential impacts of projects on forest carnivores and their habitat.

* Necessity of identifying and applying special management to breeding 'sites' (natal dens) for each forest carnivore species, similar to that applied to California spotted owls next and roost sites.

* What landscape-level fire-management strategies could be developed that reduce the potential for large, severe fires while minimizing negative effects of fire (both wildland and prescribed fire) and other fuel-treatments on forest carnivore habitat?

B. Reference other issues in this report:

* What effect has interim management, via CASPO prescription, had on the suitability and connectivity of fisher and marten habitat? How will future management for spotted owls affect the conservation and recovery of fisher populations in the Sierra? [See Issue on CALIFORNIA SPOTTED OWLS.]

* To what extent can spatially explicit modeling of the overlap of habitat needs of forest carnivores and spotted owls be shown to provide for the needs of goshawks as well? Would the maintenance of habitat attributes needed by goshawks, when added to those maintained for spotted owls, fishers and martens enlarge the array of plant and animal species protected in mature and older forests of the Sierra Nevada? [See Issue on OLD-FOREST ECOSYSTEMS: (1).]

* How has previous timber management in the Sierra Nevada affected the abundance of large trees, snags, and logs (conifer *and* hardwood) and, therefore, habitat for fishers and martens? How will future prescriptions affect the attrition of existing potential resting structures and the recruitment of new structures? [See Issue on OLD-FOREST ECOSYSTEMS: (1).]

* AQUATIC/RIPARIAN: How will guidelines for the treatment of aquatic and riparian areas affect the value of these important areas as resting, foraging, and travel habitat for fishers and martens? If buffer distances are used, how does the width influence the use of riparian areas by fishers and martens? [See Issue on AQUATIC/RIPARIAN.]

* How can landscapes with habitat currently occupied by fishers be treated to reduce the potential for large, severe fires without risking the loss of fishers from the area, or significant long-term loss in habitat quality? How can forest land in the portion of the Sierra that is currently unoccupied by fishers be treated to accelerate--or at least not delay--the recovery of habitat and potential for recolonization by fishers? How do prescribed fire, or silvicultural methods intended to mimic the effects of fire, immediately affect the quality of habitat for fishers and martens, and also affect the trajectory over time of habitat development? [See Issue on FIRE AND FUELS.]

* How can off-highway vehicle uses, during summer and winter, be managed to minimize habitat, use reproduction, and survival of forest carnivores? [See Issues on CULTURAL, DEMOGRAPHIC AND SOCIOECONOMIC CHANGES and ROADS.]

PRIORITY ISSUES FOR SIERRA NEVADA CONSERVATION

Issue: AQUATIC, RIPARIAN, AND MEADOW ECOSYSTEMS: (1) LOW- TO MID-ELEVATION

Synopsis

* Water is the most important commodity produced from Sierra Nevada ecosystems, contributing 61% of the direct worth (Stewart 1996).

* Dams and diversions create a significant cumulative impact on Sierra Nevada waters; only three rivers greater than 100 miles long flow freely (Clavey, Middle Fork Cosumnes, and South Fork Merced Rivers). The storage capacity of all dams is about 36.6 billion cubic yards, which is about the average annual stream flow produced in the range. In the Mono/Owens River basins, 1200 miles of 1350 miles of streams are affected by diversions. (Summarized from Kattlemann 1996, Kondolf et al. 1996.)

* Recovery from historic (19th and early 20th centuries) impacts of hydraulic and placer mining, dredging, overgrazing, clearcutting, and fires on aquatic ecosystems has been high for some variables such as erosion and sediment, direct pollution, and riparian vegetation. (Summarized from Kattlemann 1996, Kondolf et al. 1996.)

* Twenty percent of 401 Sierra Nevada vertebrate species depend on riparian habitats; 24% of these are at risk (Graber 1996).

* Fifty percent of 30 native Sierra Nevada amphibian species are considered at risk of extinction (Jennings 1996, Graber 1996). [See Issue on FROGS AND TOADS.]

* Seventeen percent of over 3,500 Sierra Nevada vascular plant species occur in riparian areas (Davis and Stoms 1996, Graber 1996, Shevock 1996).

* Little is known of the amount and distribution of aquatic invertebrates. New studies, however, indicate high endemism and great diversity within and among sites. For instance, of major aquatic insect groups, 19% of caddisflies and 25% of stoneflies are considered endemic to the Sierra Nevada (Erman 1996). Local disturbances appear likely to have significant impacts on this diversity (Erman 1996, Roby and Azuma 1995).

*Of 40 native fish species, six are formally listed, 12 are candidates, and four are in serious decline in the Sierra (Brown and Moyle 1993, Moyle et al. 1996a). Native Chinook salmon (*Oncorhynchus tshawytscha*) have been eliminated from 90% of their Sierra Nevada habitat and now remain only in a few undammed tributaries of the Sacramento River (e.g., Deer and Mill Creeks) (Fisher 1994, Harvey 1995, Moyle et al. 1996a, Yoshiyama et al. 1996). Increased sedimentation rates from forest activities have degraded fish spawning habitats (Moyle et al. 1996a) as well as macroinvertebrate habitat (Erman 1996, Roby and Azuma 1995).

* Thirty nonnative fish species have become established in Sierra Nevada waters due to stocking; 10 are widespread and abundant. Introduced trout are present in most Sierra Nevada

waters, including hundreds of miles of streams and over 4,000 lakes that were formerly dominated by invertebrates and frogs. (Baltz and Moyle 1993, Knapp 1996).

* Of 67 types of aquatic habitat mapped for the Sierra, 64% are declining in quality and abundance, and many are at risk of disappearance (Moyle 1996a, Moyle 1996b, Moyle and Yoshiyama 1994, Moyle et al. 1996a; 1996b; 1996c).

* Continuing degradation of riparian and aquatic habitat and biodiversity has been linked to impacts from dams and diversions, overgrazing, mining, roads, logging, direct changes to stream channels and stream flows, and loss of stream area by submersion under reservoirs (Gard 1994, Kattlemann 1996, Kattlemann and Embury 1996, Kondolf et al. 1996).

* Quality of aquatic and riparian habitat is directly related to integrity of adjacent uplands; narrow streamside buffers from land disturbance have frequently been documented to be inadequate to conserve habitat and populations of dependent species (Erman 1996, Kondolf et al. 1996).

* Recent tree-ring, fire scar data from mixed-conifer forest landscapes suggest that fires were an ecological process influencing the development of encompassed riparian areas (Fites-Kaufamann 1997, Skinner and Chang 1996). While riparian zones along permanent water courses appear to have had more variable fire-return intervals than surrounding landscapes (Skinner and Chang 1996, Skinner in press), those in the upper reaches along or within ephemeral or intermittent water courses appear to be more likely to have had fire-return intervals similar to the surrounding landscape (Skinner in press).

* Fire-scar studies suggest that pre-1850 riparian zones along permanent water courses may have contributed to the development of general landscape heterogeneity beyond the riparian zone by acting as periodic barriers to the movement of fires across landscapes (Skinner and Chang 1996, Skinner in press).

Additional References: Berg et al. 1996, Bradford et al. 1994, Brown and Moyle 1993, Costick 1996, CSLC 1993, Dudley and Dietrich1995, Erman and Erman 1995, Griggs et al. 1994, Herbst and Bradley 1993, Herpst and Knapp 1995a; 1995b, Jenkins et al. 1994, Jennings and Hayes 1994, Jennings et al. 1992, Kimsey 1996, Kinney 1996, Kondolf 1994, Kondolf and Vorster 1994, McGurk and Fong 1995, Moyle 1996, Shevock 1996, Manley et al. 1995, Menke et al. 1996, Mount 1995, Moyle 1995, Moyle and Randall 1996, Overton et al. 1994, Parrish and Matthews 1993, Williams and Spooner 1998.

<u>Basis for Inclusion</u>

* Aquatic/riparian ecosystems have been ranked as having much greater biodiversity than adjacent uplands and providing significant food and habitat for upland species (Kondolf et al. 1996); they are recognized as one of the three most altered and impaired ecosystems of the Sierra (Graber 1996)

* National forest management could accelerate recovery from historic impacts and minimize impacts from recent and continuing activities.

Geographic Region of Concern

* Streams, lakes, wetlands, and associated communities Sierra-Nevada-wide.

Primary Scales for Consideration

* River basins, with emphasis on planning watersheds; fine-scale features such as seeps, springs, bogs.

Relationship with National Forest Management

A. Reference above Synopsis:

* How might cumulative effects analysis and watershed analysis be integrated in national forest planning to advance watershed-management needs?

* How might spatially explicit and previously identified areas of high aquatic values be incorporated into national forest management?

* What opportunities exist to restore watershed function?

B. Reference other issues in this report:

* Appropriate characterizations of historic range of conditions in riparian ecosystems that include the influence of fire will likely be a necessary element to consider in development of effective, long-term landscape strategies for fire management. [See Issue on FIRE AND FUELS.]

* What opportunities exist to remove, maintain, or improve road quality for riparian/aquatic protection? [See Issue on ROADS.]

PRIORITY ISSUES FOR SIERRA NEVADA MANAGEMENT

Issue: AQUATIC, RIPARIAN, AND MEADOW ECOSYSTEMS: (2) HIGH ELEVATION

Synopsis

* High-elevation, native amphibians have been declining in numbers steadily over the last century. [See Issue on FROGS AND TOADS.]

* Several native high-elevation fishes are also in decline. Declines in golden trouts (*Oncorhynchus mykiss gilberti, O.m. whitei,* and *O.m.aquabonita*) are associated with hybridization, competition, and predation by introduced fish in native trout habitat (Knapp 1996, Moyle et al. 1996a).

* Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) has been declining historically (last century) and now occupies only a fraction of its former known range. Genetically pure populations remain on national forest lands above 6000 feet. Impacts are related to competition and hybridization with introduced trout, water diversions, stream channelization, and grazing-related changes in habitat (Moyle et al. 1996a).

* As a result of artificial stocking, the proportion of trout-containing lakes in the Sierra Nevada overall larger than 2.5 acres (about 4000 total) has increased from 1% to 63%; on national forests, the increase is to about 85% (Knapp 1996).

* Fish introduction likely disturbs additional native aquatic biota that existed historically (pre-1850s) in fishless lakes. Cumulative effects from widespread stocking likely are creating rangewide changes in aquatic fauna (Erman 1996, Knapp 1996).

* Following intense historic (1800s/early 1900s) overgrazing, many mid- to high-elevation meadows have been eroding, with small meadows completely lost. Channel cutting has altered the hydrologic condition of many meadows with the overall result that they are being transformed from sites of sediment deposition and storage to sources of sediment, and many plant communities changed from wet to dry types. The relative contributions of early domestic grazing and natural climate change in the last 200 years (which resulted in similar environmental effects, Wood 1975) to these landscape effects is poorly understood. (Summarized from Hagberg 1995, Kattlemann 1996, Kattlemann and Embury 1996, Kondolf et al. 1996, Moyle et al. 1996c.)

* Characterization of pre-1850s conditions of montane meadows is poor, due to lack of ungrazed areas as reference and to lack of understanding of the role of historic fire (Hagberg 1995).

Additional References: Bradford et al. 1994, La Boa et al. 1994, Sherman and Morton 1993.

Basis for Inclusion

* Declines in frog populations have been steady and widespread, reaching critical levels where rapid extirpations are likely. Several species are listed or candidates for listing.

* Golden trout (*O.m. whitei*) is listed as federally endangered; .*O. m. gilberti* and *O. m. aquabonita* are federal candidates for listing.

* Lahontan cutthroat trout is federally listed as threatened.

* Distributed reduction of stocking in a small proportion of lakes could revert them to fishless and provide habitat for population recovery, recolonization, and potential restoration of high-elevations amphibians (Matthews, pers. comm. and Knapp, pers. comm.).

<u>Geographic Region of Concern</u>

* High Sierra, above 5000 feet.

<u>Primary Scales for Consideration</u>

* Species-level issues suggest implementation at watershed scale; within watersheds, metapopulaton behaviors suggest scales of interconnected lakes and streams.

<u>Relationship with National Forest Management</u>

A. Reference above Synopsis:

* What gains can be made in coordinating with California Department of Fish and Game to evaluate fish-stocking levels and distribution, and to implement aquatic restoration?

B. Reference other issues in this report:

* How might demands for sport fishing be balanced with protection of amphibian and golden trout habitats? [See Issue on FROGS AND TOADS.]

* What are effects of *current* high elevation grazing on aquatic, riparian, and meadow conditions and how might range management practices continue to improve status of aquatic biota? [See Issue on GRAZING.]

PRIORITY ISSUES FOR SIERRA NEVADA CONSERVATION

Issue: AQUATIC, RIPARIAN, AND MEADOW ECOSYSTEMS: (3) FROGS and TOADS

Synopsis

* Over 50% of the 30 native Sierra Nevada amphibian species have experienced population declines and are in need of protection in order to survive. The most at-risk species are closely tied to aquatic and riparian habitats, and include the true frogs (*Rana* spp.) and toads (*Bufo* spp.). Populations of most species of salamanders, which are terrestrial, are considered to be less at risk. The spadefoot toad occurs only on the western edge of the Sierra foothills and has been impacted primarily by agriculture and urbanization (Jennings 1996).

* The causes of frog and toad population declines are not wholly understood and differ depending on latitude, altitude, and species. Low elevation species, such as the foothill yellow-legged frog (*Rana boylii)* and the California red-legged frog (*R. aurora draytonii*) have been most impacted by alteration of streams and wetland habitats as a result of grazing, mining, reservoir construction, and urbanization (Jennings 1996). Exotic predators, including numerous fish species and the bullfrog (*R. catesbeiana*), prey on native frog/toad larvae and adults (Drost and Fellers 1996, Jennings 1996). Water and hydroelectric development may be significant factors in the decline of the foothill yellow-legged frog (e.g. Lind et al. 1996). Foothill yellow-legged frogs and California red-legged frogs have been extirpated from 66% and 99% of their historic ranges in the Sierra Nevada, respectively. The northern leopard frog (*R. pipiens*) has disappeared from almost of all of its relatively small historic range in the eastern Sierra Nevada. Grazing has been implicated as a major factor affecting the habitat of the leopard frog and the recent drought has exacerbated already tenuous conditions (Jennings and Hayes 1994).

* For high elevation species, the major causal factor in the declines appears to be introduced alien fishes, which directly prey on frog larvae and adults (Bradford et al. 1993, Knapp 1996). Because alien fish are widely distributed in high elevation lakes and streams, they also act as barriers to dispersal and re-population by native frogs (Bradford et al. 1993, Jennings 1996). Introduced fish are thought to have had major impacts on the mountain yellow-legged frog (*R. muscosa)* in the central and southern Sierra Nevada and the Cascades frog (*R. cascadae*) in the northern Sierra Nevada (Fellers and Drost 1993, Knapp 1996). Habitat alteration of meadows has been implicated in the decline of the Yosemite toad (*Bufo canorus*) (Martin 1997). The mountain yellow-legged frog, Cascades frog, and Yosemite toad have disappeared from 50%, 99%, and 50% of their historic ranges in the Sierra Nevada, respectively (Jennings 1996, Jennings and Hayes 1994).

* Other factors that may be affecting frog and toad populations, but for which evidence is currently limited, include: disease, acid precipitation, mining, pesticides (especially estrogen-mimicking compounds), automobile emissions, ultraviolet light, and drought (Drost and Fellers 1996, Fellers and Drost 1993, Jennings 1996, Sherman and Morton 1993).

* The life history of amphibians depends on metapopulation behavior. Critical levels of population fragmentation, habitat loss, and habitat isolation have recently been reached such that

populations are reduced to levels lkely to result in rapid extirpations (Jennings 1996, Jennings and Hayes 1994, Knapp 1996).

* Effects of amphibian prey loss may radiate up food chains and impact other vertebrate predators, such as snakes (Jennings et al. 1992) and birds.

Basis for Inclusion

* Amphibian species, especially frogs and toads are experiencing world-wide declines, even in relatively pristine areas (Blaustein et al. 1994, Lipps 1998, Pounds et al. 1997). The use of as bio-indicators of ecosystem stress because of their unique ecological sensitivities has been proposed (Welsh and Ollivier, in press).

* The California red-legged frog is listed as a Federal Threatened species. All the other species described above have exhibited substantial declines and are California Species of Special Concern (Jennings and Hayes 1994).

* The PSW Region of the Forest Service recently added all of the species listed above to its Sensitive Species list.

* National forest management, especially of aquatic and riparian habitats, has the potential to reduce many impacts and possibly reverse population trends of some species.

Geographic Region of Concern

* Within the Sierra Nevada, there are diverse amphibian species inhabiting a range of elevational and latitudinal zones. Of greatest concern are the status of frog and toad populations in foothill habitats (which are mainly private land) and in high elevation meadows and lakes Species-level analyses are needed to prioritize management and restoration efforts.

* Restoration of aquatic habitats throughout the Sierra Nevada has been recommended by numerous authors (Jennings 1996, Moyle and Randall 1996).

Primary Scales for Consideration

* Frogs and toads are species and habitat specific. Many amphibian populations exist in classic metapopulation arrangements because of the patchiness of their required habitats (Jennings 1996). Thus, focusing on maintenance of existing populations, restoration of declining populations, and maintaining "connections" among populations will increase the likelihood of survival and improvement of these species population status.

Relationship with National Forest Management

A. Reference above Synopsis:

* National forest management activities most linked to frogs and toads in the Sierra Nevada include: grazing, mining, agreements on fish stocking with the California Department of Fish and Game (CDFG), and permitting of water diversion projects. How might national forest activities balance these activities with habitat protection?

* Some examples of management approaches that offer balance in use and protection include:

- Seasonal restrictions on grazing and exclusion of livestock from aquatic and riparian habitats.
- Seasonal restrictions on mining to avoid breeding and rearing season of frogs and toads.
- Coordination with CDFG to analyze current fish stocking needs and plans and develop an approach that would provide some fishless watersheds in a spatial arrangement conducive to frog recovery.

- Do reviews of new permits for water diversion projects and revisions of existing permits (especially during the ongoing Federal Energy Regulatory Commission hydropower re-licensing) adequately take advantage of opportunities for restoration of frog and toad habitats?

B. Reference other issues in this report:

* Some examples of management approaches that offer balance in use and protection include:

- Development of a comprehensive aquatic conservation strategy for all aquatic habitats in the Sierra Nevada is one approach that could be considered to reduce impacts to frogs and toads. Such a strategy might be modeled after the strategy developed for public lands in the Pacific Northwest (FEMAT 1993) and could include the following integrated components: watershed assessment/analysis, reserve areas, improved management practices adjacent to and within riparian and aquatic habitats, and restoration [See Issues on AQUATIC, RIPARIAN, AND MEADOW ECOSYSTEMS, LOW- TO HIGH-ELEVATIONS AND HIGH ELEVATIONS.]

* Although timber harvesting, controlled burning, and recreation have not been directly implicated in the declines of these species, where these activities occur in or adjacent to sensitive aquatic or riparian habitats, how might national forests evaluate their potential negative effects on amphibian habitats? [See Issues on GRAZING; AQUATIC, RIPARIAN, AND MEADOW ECOSYSTEMS, LOW- TO HIGH-ELEVATIONS AND HIGH ELEVATIONS.]

PRIORITY ISSUES FOR SIERRA NEVADA CONSERVATION

Issue: AQUATIC, RIPARIAN, AND MEADOW ECOSYSTEMS: (4) WILLOW FLYCATCHER (*Empidonax traillii*)

Synopsis

* Within recent times, willow flycatchers were widespread throughout most of the Sierra Nevada, occurring primarily in riparian/willow habitat from the lower yellow pine belt through high montane elevations on the western slope and scattered on the eastern slope (Harris et al. 1987, Harris et al. 1988, Serena 1982).

* Periodic surveys in recent decades have indicated continuing declines throughout that range (Harris et al. 1987, Harris et al. 1988, Serena 1982). The latest and most thorough general survey was done in 1997. That effort surveyed 144 known historic sites, detecting willow flycatchers at only eight sites; most of those produced evidence of only single birds or single pairs (Flores, pers. comm.).

* Only one locality still has a marginally viable population. This extends generally from Perazzo Meadow (Tahoe National Forest north of Interstate 80) southward through the Truckee area to Red Lake I and Red Lake II in Alpine County (Bombay 1998; Flores, pers. comm.). Intensive surveys in that area revealed flycatchers in 31 territories at nine sites in 1997 (Bombay 1998).

* The situation is even more serious in southern portions of the Sierra Nevada. On the Sierra National Forest, for example, the most recent, forest-wide survey was done in 1995. It located only eight adults at three sites. Surveys at seven localities on the Sierra National Forest known to have willow flycatchers in the recent past detected no evidence of flycatchers, even at one location that had 12 birds detected in 1983 (Dinkey Meadow) and another that had 13 birds detected in 1984 (Long Meadow) (Cougoulat, pers. comm.). According to DeSante (1995:43), "Without question, the willow flycatcher is the most endangered landbird species in the Sierra."

* Declines are believed to be related to direct degradation of nesting and foraging habitat from livestock grazing in meadows (Graber 1996) and loss of riparian habitat (Harris et al. 1987, Harris et al. 1988, Serena 1982). Additionally, roads near meadows and logging uplsope from meadows can alter sediment delivery and both surface- and groundwater flows to the meadows (DeGraff, pers. comm.; Valentine, pers. comm.). Brood parasitism by the alien brown-headed cowbird (*Molothrus ater*) is not considered to be a serious problem at this time, although this question warrants further study. Cowbird invasion into the mountains is favored by livestock grazing, clear-cutting, and disturbances such as pack stations, picnic areas, and campgrounds (Rothstein et al. 1980, Verner and Ritter 1983).

Additional References: Kattelmann and Embury 1996, Ohmart 1994, Stafford and Valentine 1985, Taylor and Littlefield 1987.

Basis for Inclusion

* The willow flycatcher is listed as a California endangered species, and one of the subspecies is federally proposed. The species has been rapidly declining throughout the Sierra Nevada and has been extirpated from most of its former range there. Because impacts that reduce its survival are unmitigated, loss of the known remaining populations is likely without rapid mitigation and restoration efforts.

* National forest management actions have the potential to reverse population trends.

Geographic Region of Concern

* Highest priority to known remaining, extant populations, namely, Tahoe National Forest meadows along the Little Truckee River and to areas such as Perazzo Meadow and Red Lakes (not Forest Service lands) that are most likely to serve as colonizable habitat in the near future.

* Priority throughout the known historic range of the species Sierra-wide, below about 8000 feet; riparian/willow habitat on the western and eastern sides of the range, particularly at sites known to have flycatcher sightings in recent years.

Primary Scales for Consideration

* Local and focused implementation: known remaining populations/habitat of willow flycatchers and similar habitat within the historic range Sierra-wide.

Relationship with National Forest Management

A. Reference above Synopsis:

* In what ways might grazing impacts on willow flycatcher habitat be reduced or mitigated?

* What steps might be taken to restore degraded riparian and montane meadow systems?

* What changes, if any, are needed in the current, direct management of montane meadows to assure maintenance of their integrity (e.g., hydrologic functions, plant species richness and diversity, etc.)?

* What actions might be taken to assure that projects, such as timber harvest and road construction near montane meadows, do not alter markedly their hydrologic functions or sediment loads?

B. Reference other issues in this report:

* What options exist to eliminate or mitigate the impacts of livestock grazing on willow flycatcher habitat? [See Issues on AQUATIC, RIPARIAN, AND MEADOW ECOSYSTEMS (1) and (2), and GRAZING (in Appendix 1, Part 3).]

PRIORITY ISSUES FOR SIERRA CONSERVATION

Issue: LOWER WESTSIDE CONIFER/HARDWOOD ZONE

Synopsis

* Mature hardwoods of the lower conifer zone (e.g., black, canyon, and interior live oaks, [*Quercus kelloggii* , *Q. chrysolepis*, and *Q. wislizenii]* and tanoak [*Lithocarpus densiflorus*]) are critical components to Sierra Nevada ecosystems, including California spotted owls (Verner et al. 1992) and forest carnivores (Truex et al. in review, Zielinski et al. 1997a). They provide energy to animal communities in the form of acorns and foliage and, most importantly, these oaks provide cavities that are used for roosting, resting, and reproduction for many wildlife species. (Summarized from Graber 1996, Menke et al. 1996, Standiford et al. 1996.)

* The frequent occurrence of low-severity fires prior to the 1850s was likely a prominent ecological process influencing the development and maintenance of hardwood and mixed hardwood/conifer stands in much of this zone (Skinner and Chang 1996).

* Native Americans during previous centuries and millennia used fire to control conditions in oak stands, and especially to encourage acorn production within this vegetation zone. (Summarized from Anderson 1997, Anderson and Moratto 1996, Anderson et al. 1997, Skinner and Chang 1996.)

* Timber inventories by national forest in the Sierra Nevada have tended to exclude hardwood components, so that much good owl habitat (and other wildlife habitat) is not classified or mapped (Verner et al. 1992).

* Population growth doubled in the Sierra Nevada between 1970 and 1990; 40% occurred in the foothill zones of Nevada, Placer, and El Dorado Counties, including the lower and upper hardwood zones. Of the current (1990) population of the Sierra Nevada overall, 68% is in the western foothill zone (including the blue oak/foothill pine elevations) (Duane 1996a).

* Due to the long, dry season associated with lower elevations, there is a particularly high fire risk in the hardwood/conifer transition zone (McKelvey and Busse 1996). This high risk and an abundance of flammable vegetation creates an area characterized by very high fire hazard (high potential for large, severe fires) (Sapsis et al. 1996).

* Intermixed urban development in highly flammable vegetation of the lower westside conifer/hardwood zone poses significant threats to life and property from wildfire. This creates high demand for suppression activities and concentrates suppression resources in the urban intermix area during large fire events (a "suppression sink" for firefighting) (Husari and McKelvey 1996, Sapsis et al. 1996). This contributes to higher risks of large, severe fires in adjacent wildlands. Two recent examples of large, severe fire events and their potential consequences are the Stanislaus Complex in 1987 and the Fountain Fire in 1992.

* Elements of the blue oak/foothill pine [*Quercus douglasii/Pinus sabiniana*] communities that intergrade into the lower westside conifer/hardwood zone are ecologically transformed from their

pre-1850 conditions, now containing an herbaceous layer changed from largely perennial to alien annual grasses and forbs (Schwartz et al. 1996), mature and reproducing oaks decreased (Standiford et al. 1996); riparian zones lower in density and diversity (Kattlemann and Embury 1996, Kondolf et al. 1996); fire intervals have changed (McKelvey and Johnston 1992, McKelvey et al. 1996) as well as fire seasons have likely lengthened (Skinner and Chang 1996); and soil moistures and bulk densities have changed. Increasing invasion by alien plants, especially yellow star-thistle (*Centaurea solstitalis*) and Scotch broom (*Cytisus scoparius*), is impacting rare/ endemic plant species as well as overall plant diversity (Schwartz et al. 1996, Standiford et al. 1996).

* Air quality lower conifer/hardwood zones of the south Sierra-Nevada is heavily impacted by ozone and small particles from Central Valley sources, due to upslope windflow patterns. These regions suffer some of the poorest air quality in the nation. For instance, daily ozone concentrations at Ash Mountain (2200 feet) were higher than at Visalia in the Central Valley. Ecosystem impacts have been documented in conifers in this zone but have not been studied for hardwood effects. ([Summarized from Cahill et al. 1996, McBride et al. 1996.)

Additional References: Stewart 1996.

<u>Basis for Inclusion</u>

* Population pressures in this transition zone between mostly private to mostly public lands and mostly hardwood to mostly conifer zones are high, and impacts on adjacent forest lands are factors that will continue to influence national forests.

* Although mature hardwoods are key ecosystem components, they have not been well studied for their response to fire suppression and fire reintroduction within conifer-dominated forests.

* Where conifers have been harvested, the cavities in the remaining large hardwoods may be the only secure resting/roosting locations for many wildlife until the conifers grow and subsequently decay.

* The intermix of urban development in the upper foothills, including chaparral types, creates high-fire risk conditions, with the risk to urban communities from fires originating in national forest wildlands, and vice versa. The priority of suppression forces for the urban areas leaves wildlands vulnerable when fires occur near settled areas.

<u>Geographic Region of Concern</u>

* Westslope of the Sierra, below about 4500 feet.

<u>Primary Scales for Consideration</u>

* As for issues of old forests in structurally complex forest types, coordination, planning, and monitoring are suggested across the north-south extent of the range of the lower westside conifer/hardwood type in the Sierra Nevada.

Relationship with National Forest Management

A. Reference above Synopsis:

* What silvicultural opportunities exist for maintaining and recruiting hardwoods into these forests? How might national forests include hardwood components in stand inventories?

* How can the flow of invasive plants onto national forest lands as a partial result of urban and road development be mitigated?

B. Reference other issues in this report:

* How does urban development in this zone affect the capacity for fire suppression to protect natural and heritage resources? [See Issue on FIRE AND FUELS.]

* How does urban development in this zone affect the development of landscape strategies for reducing the potential of large, severe fires? [See Issue on FIRE AND FUELS.]

* How does the occurrence of many exotic, fire-adapted plants affect the ability to use prescribed fire ? [See Issue on FIRE AND FUELS.]

PRIORITY ISSUES FOR SIERRA NEVADA CONSERVATION

Issue: ROADS

* The inventoried road system within national forests of the Sierra Nevada now total over 26,000 miles of "system" roads (Maintenance Level 1 through 5) (Watkins, pers. comm.). There are an additional several thousand miles of "non-system" roads, and an undetermined amount of roads that do not appear in any inventories (Coghlan and Sowa, 1998). The actual miles of roads that are reported strongly depends upon the varying definition of what feature qualifies as a "road" and consequently the number and amount varies from document to document. However, published values generally underestimate actual miles of roads (FAC 1997).

* Gross road densities range from 1.0 miles per square mile on the Inyo National Forest to 3.6 miles per square mile on the Eldorado National Forest (USDA Forest Service 1995), although these values are also definition-dependent.

* Of the 100 watersheds in the Sierra at the "hydrologic subarea" scale (per CalWater classification), the percent of roads per watershed ranges from less than 1% to 30% of the land area. Percentage of stream lengths with a road within 100 m of the stream ranges from 2% to 33% with a median of 14% (Kondolf et al. 1996).

* Estimates suggest that road-related increases in erosion over natural rates can be several orders of magnitude (Kattlemann 1996, McGurk et al. 1996); the actual impact varies greatly with road quality, maintenance, and position in the landscape. Poorly constructed or maintained roads contribute to loss of forest productivity (Poff 1996) and reduced water quality (Kattlemann 1996) due to acceleration of erosion. Modern road construction and maintenance techniques can significantly reduce, but not eliminate erosional impact (Furniss et al. 1991).

* Roads are a significant source of habitat fragmentation and disruption in the Sierra Nevada, affect terrestrial vertebrates (e.g., martens, fishers, owls), are implicated in declines in species and population viabilities of amphibians, fishes, aquatic invertebrates, and species of riparian communities in the Sierra Nevada (Erman 1996, Jennings 1996, Kattelmann and Embury 1996, Kondolf et al. 1996, Moyle et al. 1996a). Roads have a documented role in increasing the invasion of several alien species in the Sierra, including scotch broom (*Cytisus scoparious*), star thistles (*Centaurea spp.*), and tree of heaven (*Ailianthus altissima*) (Schwartz et al. 1996). Roads are a significant cause of fragmentation of old-forest ecosystems (Franklin and Fites 1996).

* Trends show a declining rate of road construction and reconstruction. In 1994, for instance, new road construction on national forests in the Sierra Nevada was 10% the 1990 level; road reconstruction was 50% of the 1990 level. At the same time, road obliteration had increased over 30% from the 1991 level (Kattlemann 1996).

Additional References: Costick 1996, Gucinski et al. 1998, Howard 1993, McKelvey and Busse 1996, Menning et al. 1997.

Basis for Inclusion

* Roads have become a focus of significant controversy on national forests nationwide as in the Sierra Nevada. A road system is essential for use and management of Sierra Nevada national forest lands. Roads cumulatively constitute a major cause of accelerated erosion in the Sierra Nevada, creating both physical impacts (e.g., soil and slope alterations and failures, increased sediment yield, change in channel shape and function, water flow rate and temperature) and impacts to aquatic and terrestrial biota.

* Road closure, decommissioning, obliteration, reconstruction, and active maintenance can significantly reduce negative impacts of roads to ecosystems, but such actions require balancing access needs, costs, and ecosystem effects.

* The Chief of the Forest Service has focused service-wide attention to roads and roadless issues (Federal Register 63(39): 9980-9986; Feb 27, 1998). The Washington Office Roads Team is developing an Analysis Procedure and Science Synthesis, due for completion in 1998. This policy (and science background) will provide Chief's-level instruction to national forests on roads analysis and management (USDA Forest Service 1998).

Geographic Region of Concern

*Sierra-Nevada-wide.

Primary Scales for Consideration

* Evaluation and implementation at the national forest scale and smaller, but large-scale evaluation and coordination is essential to establish context, provide guidance, allocate budgets and expertise, establish schedules and accountability, and address issues that cross national forest boundaries.

Relationship with National Forest Management

A. Reference above Synopsis:

* Road projects: closure, decommissioning, obliteration, reconstruction, maintenance, and new construction funding for upgrading and maintaining roads.

* Effects on access to recreation and effects on roadless recreation; role of public roads, easements, shared ownership, jurisdiction.

* What is the role of roads in regard to production/use of timber, minerals, range, water, special forest products?

B. Reference other issues in this report:

* What effect will new road projects (and current road network) have on aquatic and riparian biota and ecosystems and on water quality? [See Issue on AQUATIC AND RIPARIAN ECOSYSTEMS.]

* What effect will road projects have on management of threatened, endangered, and sensitive species, especially California spotted owls, forest carnivores, and on invasion of alien species? [See Issues on CALIFORNIA SPOTTED OWLS, FOREST CARNIVORES.]

* Evaluation of roads projects related to fuel reduction and fire suppression goals and forest health? [See Issue on FIRE and FUELS.]

* What direct costs and revenues exist for roads projects? [See Issue on REINVESTMENT AND FUNDING.]

PRIORITY ISSUES FOR SIERRA NEVADA CONSERVATION

Issue: BIGHORN SHEEP (*Ovis canadensis*)

Synopsis

* Genetic studies indicate that bighorn sheep in the Sierra Nevada are a unique form, distinct from other bighorn sheep populations in western North America (Fitzsimmons et al. 1995, Ramey 1993; 1995, Ramey and Wehausen 1998). Due to human pressures beginning in the mid-1800s, Sierra Nevada bighorn sheep were nearly extirpated from their wide high Sierra Nevada habitat (SNBSIAG 1997, Wehausen 1988) by the mid-1900s (Wehausen et al. 1987).

* Bighorn sheep populations increased locally after reintroduction to a few select locations in 1979, but in the last decade have declined significantly; the total number is now estimated at 120-125, less than half the 250 recorded when reintroduction began (Graber 1996, SNBSIAG 1997, Wehausen, pers. comm.).

* Declines are due to cumulative stresses related primarily to transmission of respiratory bacteria from domestic sheep, causing fatal disease in bighorn sheep; mountain lion predation; encroachment on lower-elevation ranges from recreation and development; and natural effects such as heavy winters (e.g., 1995 and 1998) (Chow 1991, Foreyt 1994, Foreyt et al. 1994, Hunter 1995, Jaworski et al. 1993, Martin et al. 1994, Pybus et al. 1994, SNBSIAG 1997).

* Domestic sheep grazing allotments overlap bighorn sheep range; illegal trespass into bighorn sheep habitat occurs, increasing likelihood of disease transmission (USDI Bureau of Land Management 1992, SNBSIAG 1997).

* Mountain lion densities in the range of bighorn sheep increased over the last decades, peaking in the early 1990s. Lions have increased in the most favorable parts of sheep habitat, the lower elevations, which are critical wintering and gestation ranges. (Chow 1991, O'Connor pers comm. 1998, SNSBIAG 1997, Torres 1996, Wehausen 1996)

* Winter and summer sports activities are increasing in lower and higher elevations of sheep habitat; lower elevations are especially important winter habitat.

* The number of mature females in populations is very low; populations are spatially fragmented. These conditions are recognized by vertebrate biologists to indicate a high likelihood of even more rapid imminent decline than in recent years (Bleich et al. 1996, Chow 1991, Fitzsimmons et al. 1995)

Basis for Inclusion

* Native Sierra Nevada bighorn sheep are a unique form found only in the central and southern Sierra, are listed as threatened by the state of California, and face likely federal listing.

* After initial encouraging recovery, strong reversal in the population trend has occurred over the last 10 years, leading to precipitous decline in population numbers. The Sierra Nevada bighorn sheep is now one of the most endangered mammals of North America.

* Sierra Nevada bighorn sheep populations are considered likely to face imminent extirpation without urgent attention. Large mammals, such as bighorn sheep, that exist in such small population numbers are extremely vulnerable to forces that would not significantly affect larger populations.

* National forest and California Department of Fish and Game management actions could significantly improve chances of survival, reverse population declines, and secure population establishment.

* Changes in lion protection status have made control of depredation difficult.

<u>Geographic Region of Concern</u>

* Area of potential and likely historic (pre-extirpation) range: high Sierra above 6000 feet, south of latitudes of Walker, north of Olancha, west- and eastsides of the Sierra Nevada crest

<u>Primary Scales for Consideration</u>

*Coordinate across distribution range of sheep: Toiyabe, Stanislaus, Inyo, Sierra, Sequoia National Forests and Yosemite and Sequoia/Kings Canyon National Parks. Coordinate with California Department of Fish and Game.

* Implement at scale of present populations (planning watersheds) and greater bighorn sheep bioregions that include buffer from domestic sheep/lions/recreation; plan for increase from present marginal populations into areas of historic and potential range.

<u>Relationship with National Forest Management</u>

A. *Reference above Synopsis*:

* What opportunities exist for integrating habitat analysis and developing comprehensive long-range plans for recovery of bighorn sheep?

* Does adequate support exist for captive-breeding programs that supply reintroduction stock?

* How might national forest actions be strengthened to coordinate with California Department of Fish and Game regarding lion populations and predation in bighorn areas, including depredation and prophylactic removal or control of lions?

* Have national forest recreation assessments adequately evaluated effects of increasing recreation on bighorn habitat, especially low-elevation range, summer and winter?

B. *Reference other issues in this report:*

* Do ongoing assessments of sheep grazing allotments occur that evaluate proximity to bighorn populations and habitat; are effective actions being taken to assure isolation of domestic livestock from bighorn sheep? [See Issue on GRAZING.]

* What opportunities are being taken to use prescribed fire for habitat improvement, especially to reduce mountain lion hiding cover? [See Issue on FIRE AND FUELS.]

PRIORITY CONSIDERATIONS FOR IMPLEMENTATION

This review evaluates new science information and highlights priority issues for national forest management in the Sierra Nevada. The team was not charged to recommend specific conservation goals or objectives, nor to outline management strategies or solutions. Scientists in recent years have, however, emphasized that achievement of conservation and land-management goals in general has been hindered by institutional barriers and lack of attention to or understanding of social forces of change. Within the Forest Service, for example, functionalism, funding inadequacies, traditional ways of working internally and externally, lack of consistent collaboration with science communities, issue-driven planning versus a systems approach, ineffective monitoring, conflicting legal mandates, etc. have been identified as barriers to implementing ecosystem management. The team selected three implementation issues as having received such significant attention in recent discourse as to warrant attention rangewide by national forest management in the Sierra Nevada.

PRIORITY CONSIDERATIONS FOR IMPLEMENTATION

Issue: ADAPTIVE MANAGEMENT AND MONITORING

Synopsis

* It is not clear whether "adaptive management" projects proposed recently by national forests in the Sierra Nevada have always been based on a clear understanding of the process. Adaptive management is essential to ecosystem management, and monitoring is essential to adaptive management. In its most skeletal form, adaptive management involves predicting the effects of an action on various outcomes; assuring that the action is implemented as planned; monitoring the effects of an action on a set of structural and functional attributes of the resource ecosystem; assuring that the action is implemented as planned; monitoring the effects of the action to determine which predictions were accurate and which were not; and using the results to better understand the ecosystem and to do better planning the next time (Holling 1978, Bormann et al. 1994, FEMAT 1993, Kusel et al. 1996). Thus monitoring provides the feedback loop to improve future planning and management. Without effective monitoring, whatever else we do is not adaptive management. Consequently, monitoring must be integral to a conceptual model of how the ecosystem works (including the human element) and to management actions, and its benefits must be clear in that context. One implication is that the alternatives in a NEPA document would be likely to have different monitoring systems, each tied to the key assumptions or uncertainties of the alternatives.

* Because of the highly complex nature of ecosystem components and functions, often a lack of technical understanding about how to do monitoring in a sufficiently rigorous way, and generally high costs, monitoring is one of the most challenging tasks mandated to the national forests (Lee 1993). Effective monitoring programs must be comprehensive yet implement able. They must be designed to track key indicators of ecosystem conditions and trends and to establish whether management actions have attained stated goals. They must also include feedback loops that evaluate and incorporate new information as it is obtained (FEMAT 1993).

* Successful achievement of the monitoring component of adaptive management requires long-term fiscal commitment. Given the potentially high costs of monitoring, the investment in what to measure, at what expected precision, and how often, must be guided by an assessment of the risks associated with assumptions made when formulating plans, including the level of uncertainty in the science that undergirds those plans. Based on such a risk assessment, priorities for monitoring may be set.

* Adaptive management and monitoring include more than traditional data collection and analysis of environmental variables (Everett et al. 1993, Kusel et al. 1996). Dynamic ecological and social systems require institutional policies that are more capable of monitoring changes in human-nature interactions, and responding to these changes more effective than the Forest Service has in the past (Cortner et al. 1995, Gunderson et al. 1995). Adaptive, flexible institutions, fluid boundaries among agencies, open and collaborative planning and management, public engagement, close collaboration with science communities, risk analysis, and risk-taking will better enable national forests to conduct effect monitoring and meet sustainable science-based

management goals (Cortner and Shannon 1993, Gericke and Sullivan 1994, Kusel et al. 1996, Lee 1993, Mohai 1995, SPDR 1997).

* A common information problem encountered in landscape and ecosystem planning efforts is poor identification and integration of geographic and temporal scales of data (Nechodom and Greenwood 1998, and later section of this report, "Issues for Further Clarification, Old Forests"). Effective monitoring would generate information at appropriate spatial scales of ecosystem and social relevance and use this to adjust management.

* Declining federal budgets and shrinking specialist workforces on the Sierra Nevada national forests have affected their ability to implement monitoring programs. This is especially critical in situations where laws dictate surveys and evaluations prior to projects (e.g., NEPA, National Historic Preservation Act) that would be assumed to provide protection, but skeletal staffs and budgets compromise the adequacy of compliance. The challenge here is to design a monitoring system that can and will be implemented within likely budget and human resources.

* Broad-based convenors of monitoring and adaptive management programs, as well as central caretakers of data, are lacking in the Sierra Nevada. Centralized data access and distribution of new data are keys to successful local and regional implementation (SNEP 1996 Vol. 1).

Additional References: FAC 1997, Holling and Meffe 1996, Hunsaker et al. in prep., Kennedy and Mincolla 1982, Kusel 1996a; 1996b, Lidecap 1995, Mulder et al. 1997, North 1990, SPAMT 1998, Ruth 1996, Ruth and Standiford 1994, Sabatier et al. 1995, Starrs 1996, Stewart 1996, USDA Forest Service 1995, Yaffee 1994.

Basis for Inclusion

* Recognition of the need for effective and practical monitoring has increased in recent years, with emphasis on both predictive and retrospective monitoring. Increased attention to monitoring in the Sierra Nevada has led to initiation of a comprehensive monitoring design, the Sierran Province Assessment and Monitoring proposal (SPAMT 1998, Manley et al. in prep.). This in turn may serve as a foundation for integrating adaptive management into future forest management, and coordinating across broad geographic scales in addition to project-level monitoring.

Geographic Region of Concern

* Sierra-Nevada-wide, highest priority to regions where ecosystem/social issues are identified (e.g., by this report) to be most urgent.

Primary Scales for Consideration

* Implementation is suggested at multiple scales, varying with the issue. Key scales are:

- Sierra-Nevada-wide;
- Subregions in the Sierra Nevada;
- Planning watersheds or similar planning units;

- Local site.

* Coordination among levels for planning, evaluation, and implementation is also critical, as is being fostered by Task 4 of the Sierra Nevada Conservation and Collaboration Framework..

Relationship with National Forest Management

A. Reference above Synopsis:

* How can national forest workforces be given appropriate priority and training for successful implementation of adaptive management and monitoring?

* What mechanisms can be used to improve and favor long-term fiscal commitments to adaptive management and monitoring?

* What relevant database programs can serve to integrate monitoring objectives?

* How might NEPA and public participation processes be used to incorporate alternative monitoring strategies and effective feedback loops to management?

* How might research, including Forest Service and external scientists, become more involved in scientific integration and consistency reviews for adaptive management and monitoring?

* What opportunities could be promoted for interagency and community/county/state coordination, coordination with local partnerships, special interest groups, and communities of place (i.e., communities focused on local geographic areas)?

PRIORITY CONSIDERATIONS FOR IMPLEMENTATION

Issue: EFFECTS OF CALIFORNIA SPOTTED OWL (CASPO) INTERIM MANAGEMENT

Synopsis

* There is considerable anecdotal discussion about the effects of California Spotted owl (CASPO) interim management on ecological and socioeconomic conditions of Sierra Nevada national forests and communities, but no regional or rangewide evaluation has been done, and little information is available to provide a serious review at any scale.

* To assess the impacts of CASPO interim guidelines requires a dedicated study assessing the extent of projects implemented under CASPO, evaluation of compliance in implementing policy, plot-based monitoring of effects on ecological conditions (spotted owls and others), and review and compilation of socioeconomic effects related to timber harvest, wildfire, road projects, etc.

Basis for Inclusion

* CASPO guidelines were put into effect to benefit spotted owl habitat. Because they were intended to be in effect only 2 years but have actually remained current for 5 years, their effectiveness, any undesired consequences to other ecological resources, and socioeconomic conditions, may be accruing but have not been comprehensively monitored.

Geographic Region of Concern

* Geographic range of CASPO guidelines, particularly national forest zones below Wilderness, mostly westslope, range of spotted owls and adjacent communities.

Primary Scales for Consideration

* Assess local to regional to Sierra rangewide; some conditions (especially social) are responsive also to complex out-of-region forces and stressors.

* Attribution of effects: ecological and social trends that can be monitored after only a few years are unlikely to be accurately partitioned to CASPO versus other causes. Effects on most resources are likely responding to combined effects of shorter- and longer-term cumulative management. Short-term trends may indicate only partly the effectiveness or consequences of CASPO management. Monitoring needs to be tied to long-term programs (see section on Adaptive Management and Monitoring).

Relationship with National Forest Management

A. Reference above Synopsis:

* What level of compliance within and across national forests has occurred in the implementation of CASPO?

B. Reference other issues in this report:

* Might the prolonged duration of the interim guides result in unanticipated, negative impacts on spotted owls? [See Issue on CALIFORNIA SPOTTED OWL.]

* What has been the effectiveness of treatments implemented under adaptive management of CASPO? How have monitoring and feedback to management been linked? [See Issues on ADAPTIVE MANAGEMENT AND MONITORING, CALIFORNIA SPOTTED OWL.]

* What effects have CASPO treatments had on timber targets, local economies, roads projects, viabilities of forest carnivores? [See Issues on ROADS, FOREST CARNIVORES.]

PRIORITY CONSIDERATIONS FOR IMPLEMENTATION

Issue: REINVESTMENT and FUNDING FOR ECOSYSTEM MANAGEMENT

Synopsis

* Based on direct resource values, Sierra Nevada ecosystems produce about $2.2 billion worth of commodities and services annually. These values do not include the total revenue produced by resource-dependent activities, a figure that would be many times higher. Ecosystems on national forest lands account for about 80% of the overall total. Water is the most valued resource, producing 61% of the total ecosystem worth from the Sierra Nevada; national forests produce nearly all of the water values. (Summarized from Stewart 1996.)

* Reinvestment in the ecosystems that produce the commodities and services is extremely low, given the costs of land and water management, conservation, and restoration. Virtually no return to ecosystems comes from water. Public recreation on national forests (which accounts for about 10% of total Sierra Nevada worth) is funded almost entirely (except for a few pilot fee programs) from general funds and not direct user fees, thus recreation also produces virtually no return to the ecosystem. Public grazing (which contributes 1% of total Sierra Nevada resource value) is estimated to produce a deficit return of $7 million due to the high costs of administration and the fact that public grazing fees are far below those charged by private land owners (i.e., public funds are subsidizing grazing). (Summarized from Stewart 1996.)

* Public timber returns $23 million annually of the direct value to Sierra Nevada ecosystem management. Public timber accounts for about 7% of total Sierra resource values. Declines in timber harvest translate to smaller returns for watershed conservation and fuels management (CCSCE 1996, Stewart 1996).

* Considering water, public recreation, public timber, and public grazing together, of the $1.7 billion worth of commodities and services derived directly from national forest ecosystems, less than 1% is reinvested in land and water management and restoration (Stewart 1996).

* The costs of ecosystem management practices to sustain and enhance Sierra Nevada ecosystems are estimated to be far greater in all ecosystem areas for the future than they have been in the past (CCSCE 1996, Stewart 1996).

Additional References: California Board of Forestry 1996, Damon-Runyon 1995, Duane 1996a, Duane 1996b, Kusel 1996a; 1996b, Larson 1996, Loomis and Gonzales-Caban 1997, Marvin 1996, McWilliams and Goldman 1994, Kusel et al. 1996b, Doak and Kusel 1996.

Basis for Inclusion

* Costs of ecosystem management in the Sierra Nevada are increasing, public workforce and available federal budgets are declining. To achieve goals of sustaining and enhancing ecosystems requires finding ways of returning a larger percentage of value from public resources to local management and conservation.

Geographic Region of Concern

* Sierra-Nevada-wide.

Primary Scales for Consideration

* Local to regional to national.

Relationship with National Forest Management

A. Reference above Synopsis:

* What opportunities exist to apply innovative uses of Forest Service "Reinvention" status, Fee programs, enterprise teams, shared services, etc. to meet ecosystem management goals?

* How might national forests assess returns of fees, evaluations of costs for timber, water and recreation projects and use to improve availability to local ecosystem management projects?

* How might inter-agency and inter-institutional coordination be improved?

* What opportunities exist to foster reinvestment in Sierra Nevada communities and social goods?

ISSUES FOR FURTHER CLARIFICATION

Although ideally the products and reports of scientific research would give clear resolution of conservation and management issues, analysis in environmental fields rarely provides finality. In this section we identify five issues (*Old-Forest Ecosystems; Aquatic and Riparian Management; Grazing; Priorities for Conservation of Biodiversity; and Science and Collaboration*) that, for different reasons, deserve additional scientific evaluation in the upcoming Environmental Impact Statement (EIS) effort (i.e., Task 3). For each of these, we recommend that the Forest Service Pacific Southwest (PSW) Region and Research Station schedule technical workshops, arrange for specialists to review and debate additional literature and information, and for scientists to interact closely with the EIS team and public while developing proposed actions and alternatives. The complexity of information, diverse perspectives surrounding these issues, and their importance to Sierra Nevada ecosystems dictate that they deserve special attention.

OLD-FOREST ECOSYSTEMS

The topic of multiple definitions for old-forest ecosystems arose most recently during discussion of Task 1, where it became clear that the different treatments of old forests in the scientific and management literature make policy decisions especially challenging. Due to different perspectives and objectives of authors, studies have focused on different aspects of the old forests, offered various definitions of old-forest ecosystems, mapped and inventoried old forests according to different standards, and suggested different management solutions. In Appendix I, Part 1, we include information developed during Task 2 that begins to display the treatments in a way that would clarify why different interpretations have arisen. Reviewers more familiar with forest succession than the review team (see Appendix II) indicated that important old-forest treatments were missing from our report. Further, outside our charge but critical to Task 3 is an interpretation of which elements of the different old-forest treatments should be incorporated into the upcoming NEPA planning. For these reasons we encourage the Forest Service PSW Region and Research Station to take this topic up in Task 3.

The following old-forest treatments were identified as being in use for Sierra Nevada forests. Those indicated with an asterisk are briefly summarized in Appendix I, Part 1.

- California Wildlife Habitat Relations
- US Forest Service, Timber Strata
- *SNEP 1996
- *Sierra Biodiversity Institute (in Davis 1996)
  *US Forest Service Forest Inventory and Analysis; Ecological Classification (USDA Forest Service 1995, 1996, Beardsley et al. in press)
- *CASPO Interim Guidelines (Verner et al. 1992, USDA Forest Service 1995, 1996)
- *Carnivore Habitat (USDA Forest Service 1995, Freel 1991)
- *Lake Tahoe Forest Health Consensus Group (FHCG 1998)
- *Quincy Library Group

AQUATIC AND RIPARIAN MANAGEMENT

The topic of multiple approaches to aquatic and riparian management also arose most recently during Task 1. Aquatic and riparian issues have been identified as high priority for management throughout western North America. Several bioregional assessments, as well as earlier (withdrawn) drafts of Sierra Nevada environmental documents, have developed alternative approaches to bioregional aquatic and riparian management. The scientific bases for these vary with assessment authors, depending, among other things, on emphasis (e.g., physical and geomorphic elements versus aquatic biota and riparian communities). Most recently, confusion has arisen while trying to develop Sierra Nevada programs over the meanings and interpretations of different aquatic and riparian treatments by FEMAT (1993) versus SNEP (1996). In earlier drafts of this report (6/16/98 and 7/10/98 versions), we presented a section where we compared approaches to this topic developed in the two assessment reports.

Late in Task 2, one blind peer reviewer of the 7/10/98 draft pointed out (Appendix II) that the science foundations and management approaches developed in the reports of the Interior Colombia River Basin (CRB) assessment (Quigley et al. 1996, USDA Forest Service and USDA Bureau of Land Management 1997) shed significant light on new science and comprehensive solutions to aquatic and riparian management. Because this review arrived too late for us to adequately incorporate CRB science and management, we moved our original material comparing SNEP and FEMAT to Appendix I, Part 2, acknowledge this important omission in our report, and recommend that the Region and Station bring scientists knowledgeable on CRB science and management strategies to consult during the upcoming Task 3.

GRAZING

Because various segments of the public continue to have different views about the effects of grazing on resources in the national forests, and because new information is available (primarily in the SNEP reports), we early selected grazing as an issue to address in the science review. In the draft report dated 7/10/98, which was subjected to outside, blind peer reviews by eight scientists separately, this issue appeared as "AQUATIC, RIPARIAN, AND MEADOW ECOSYSTEMS: (3) GRAZING." Several reviewers, both among those submitting signed reviews (draft of 6/16/98) and those in the group providing blind review comments (7/10/98 draft) took strong issue with many points in draft versions of the grazing issue (see Appendix II).

The thoughtful and constructive comments of these reviewers, pointing out areas where new science as presented in the SNEP reports may not be fully accurate, quickly led us to recognize that some of the reviewers possess a level of scientific expertise on grazing well beyond that of any member of our team. Because many of the most challenging review comments arrived too late for us to respond in a fair and comprehensive way, an alternative solution was needed. The final draft version (7/10/98) of the text for the grazing issue now appears in Appendix 1, Part 3. We recommend that persons responsible for Task 3 arrange workshops involving acknowledged authorities on the issues of grazing in the national forests, as well as others representing divergent viewpoints on this issue, to seek a resolution of the true state of our current knowledge about grazing in national forests of the Sierra Nevada.

PRIORITIES FOR CONSERVATION OF BIODIVERSITY

The scientific basis for choosing species that are either indicative of ecosystem change or that provide "umbrella" protection for other co-occurring species (e.g., Noss 1991) is not well developed. The most common application of the indicator species concept has been criticized (e.g. Landres et al. 1988, Niemi et al. 1997) and the collateral benefits to other species of managing for single umbrella species have not been well established (Launer and Murphy 1994, Berger 1997). Ideally, an unambiguous and scientific process should be used to select focal species (or other elements of biodiversity) that are most sensitive to the types of human activities that affect the forests of the Sierra Nevada.

Risk assessments are one option for achieving this goal. In these assessments, species are prioritized on the basis of characteristics that make them vulnerable to population decline or extinction, such as life history characteristics, population size and trend, habitat specificity, area requirements, vagility and geographic range size (Ahern et al. 1985, Allendorf et al. 1997, Given and Norton 1993, Lambeck 1997, Laurence 1991, Mace and Lande 1991, Millsap et al. 1990, Molloy and Davis 1994, Pimm et al. 1988). Each assessment produces a list of species that highlights those taxa most susceptible to additional population decline or habitat loss and which should receive immediate management attention. A risk assessment for the 491 species of nonaquatic vertebrates in the Sierra Nevada is underway (SPAMT, in prep) but may not be completed in time to be of value for the upcoming planning effort.

Lacking a formal risk assessment for species in the Sierra Nevada, the criteria described in the introductory section, "Science Team Approach and Organization of the Review," were used to help decide which species to single out for special attention in this report. The species emphasized in this report were selected for one or more of the following: they were previously identified as key issues; they appear to have promise as "umbrella" species--species whose conservation can assure the maintenance of many other species; their situation appears to be particularly tenuous and urgent at this time. Many other species, both plants and animals, are also known to be in various states of decline and/or sensitivity, but it was beyond the reach of this report's time frame to provide details for all of these species. For example, based on the U.S. Fish and Wildlife Service's annual Breeding Bird Survey for California as a whole, 22 species of birds that include the Sierra Nevada within their breeding range declined significantly in number from 1980 through 1994. The pine siskin is the extreme example, having declined at a mean annual rate of 13.0%. At this rate, a hypothetical population of 1000 siskins would have declined to a population of 142 during that period. We must leave it to persons involved with completing Task 3 of this overall effort to consider what, if anything, the Forest Service may do to manage for such species in the Sierra Nevada.

SCIENCE AND COLLABORATION

National forest policy supports the formation of collaborative partnerships that will bring scientists together with managers and the public. This is especially critical in urban-wildland intermix zones where culture, socioeconomics, and institutions are changing rapidly (Wellman and

Tipple 1994). One objective is to open the scientific process to nonscientists so they understand how assumptions or hypotheses are constructed, the styles and methods for pursuing different lines of inquiry, logical and interpretive steps (and sometimes leaps), the act of synthesis, and the nature of uncertainty, complexity, and systems change. A second objective is to make available to scientists knowledge about biophysical and social conditions under examination. Many aspects of scientist-manager-public collaboration need to be clarified and examined. It was not possible for this report. Just a few of the questions are: What formats (e.g., public forums or individual interviews) are best for the exchange of information between scientists and the public? What methods of quality control can be applied to different kinds of information provided by the public? When is public involvement in monitoring design and implementation helpful? How can scientists be educated about the purposes and benefits of collaborating with the public? We need a full examination of successes and failures so we can construct effective arrangements that will enhance the science and improve ecosystem understanding by managers and public.

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APPENDIX I

ISSUES FOR FURTHER CLARIFICATION: EXPANDED DISCUSSIONS

Note to readers: See comments in text section, "Issues for Further Clarification" for context of these appendices.

APPENDIX I, PART 1
APPROACHES TO DEFINING AND MEASURING OLD-FOREST ECOSYSTEMS

General Approaches to Studying Old-Forest Ecosystems

In the last two decades, old-forest ecosystems have emerged in the academic literature. Research has documented that these ecosystems, also known as old-growth or late seral forests, are unique components of native forests, possessing discrete structures, functions, and histories that differ from those of younger or simplified forests. Old forests have now been studied more in some parts of the world than in others, and in some forest types disproportionately. They have been studied with emphasis on certain parts, including their genetic diversity, woody and nonwoody vegetation components, nutrient relations; as habitat for vertebrate and invertebrate animals; for watershed function; as a function of disturbance (primarily fire and insects/pathogens); and for their wilderness and esthetic values. They have been studied from long versus short historic timespans, and from site to landscape level geographic scales. Because old forests are complex and dynamic ecosystems, definitions and descriptions have varied depending on perspectives of the authors. Thus, when assumptions are unstated, confusion and misunderstandings arise even among specialists. This is especially true when recommendations are made for managing old-forests, because different approaches may be put forward to meet different goals, while underlying assumptions are not understood clearly so pros and cons of different approaches are difficult to evaluate.

The following discussion is presented to clarify different approaches that have been offered to understand and manage old-forest ecosystems in general and in the Sierra Nevada in particular. Being aware of the diverse perspectives and emphases of different old-forest scholars will help ensure that information is used in the most appropriate way. The following questions may be useful to keep in mind when reading different treatments. A reader should be aware that extensions of findings about one element of old-forests (or place or scale) to others may not apply.

- *What variables and what methods are used to describe old-forest conditions*? The most common variable used to describe old forests is old trees, although different size and age criteria are used by studies due to different objectives. Beyond that, different authors use different groups of old-forest attributes, variably emphasizing structural complexity, species composition, soils, litter, canopy cover, snags and woody debris, disturbance histories, and health attributes. Methods to assess old forests vary also with intent of the study, including ground-based plots (usually emphasizing small areas), remote-sensing approaches, air- and ortho-photo delineations, and specialist experience. Often methods are combined in various ways.

• *What geographic region of the world/the Sierra Nevada does a study reference?* Studies in different geographic regions of the world may not apply to Sierra Nevada conditions. Much of our understanding of general roles and functions of old forests has been developed in the mesic Pacific Northwest; it is not clear whether and which roles and function of westside Cascade old forests are common to old forests in the Sierra Nevada.

• *What forest type does a study address*? Structural attributes, biodiversity components, disturbance roles, and ecosystem functions of old forests differ greatly among forest types of the Sierra Nevada. Many attributes differ among forests of different elevation and aspect (especially west- versus eastside of the Sierra Nevada crest). Within a particular species type, changes in associated biodiversity occur from north to south. For instance, only 50% of the plants in the northern portion of the mixed-conifer forest are shared with the southern portion (Davis and Stoms 1996) and changes in plant species composition were found to be one species lost or gained per 0.6 mile (Walker 1992).

• *What geographic scale is referenced*? Within forest types, old-forest ecosystems are recognized at multiple geographic scales, from single trees to stands to landscape units. Depending on the objective of a particular study, different scales are used and sometimes it is not clearly articulated which ones are the focus.

• *What time scale is referenced*? Authors treat Sierra Nevada old-forest conditions with regard to multiple time scales, often comparing existing conditions to some presumed historic/prehistoric time period or looking to range of historic variability over specific or ill-defined time periods. Periods of historic conditions are often referenced as "ideal" snapshots of undisturbed conditions.

• *What disturbance regimes are referenced*? Fire and insects/pathogens are considered major forces influencing the structure and function of old forests in the Sierra Nevada below the subalpine zone. The sizes of forest patches and openings; of polygon extent, composition and shape; of compositions, ages, and densities of trees and associated plants; vertical structure; legacy elements; and downed wood types and distribution are among some of the elements that are strongly influenced by the specific fire history of a site. Studies of current fire patterns and of historic fire regimes show that the effect of fire varies with forest type, with elevation, aspect, and slope, from south to north and west to east in the range, and with specific disturbance history. Fire regimes have changed over time, related to natural climate and environmental changes, with the associated assumption that these changes in disturbance resulted in variation over time in old-forest conditions. Because of the prevalent role of fire naturally, it is incomplete to describe or discuss natural forest conditions without also referencing fire regimes and their changes over time, although some studies do not provide this reference.

• *What individual element(s) of old-forest ecosystems is (are) emphasized and what goals and objectives are intended to be met by various studies and proposed management strategies*? Definitions of old forests strongly depend on the perspective of the observer and the intent of a study or management objective. Some scientists view old forests as wildlife habitat, thus define and weight elements that are significant to various animal species. Some consider the genetic landscape and view changing patterns of gene pools over space, others view changing species diversities. Some study vegetation dynamics, with temporal scales ranging from paleohistoric to recent ("potential vegetation") to current ("existing vegetation"). Different views of disturbance

lead to different interpretations of the patterns of succession and thus to different views on resulting old-forest vegetation structure and on natural fire regimes. Management strategies also tend to emphasize certain elements of old forests more than others.

Current Approaches to Defining and Inventorying Old forests in the Sierra Nevada

There are several approaches to studying old forests in the Sierra Nevada currently in the literature and in general scientific and conservation discussion. They range from explicit and documented to *ad hoc* and inferential. Some give explicit attention to management of old forests, others treat it indirectly. Some address several to many scales, others emphasize a particular scale. Definitions vary among authors. For instance Bolsinger and Waddell (1993) found 10 different definitions applied to one forest type. Only a brief summary of some of the approaches currently in use for the Sierra Nevada is given here.

SNEP: Structural Complexity: Rangewide Standards (SNEP 1996)
Definition: Old forests in general: "Forests that have developed over one to many centuries without a major disturbance" (Franklin and Fites 1996). In Sierra Nevada: structurally complex, spatially heterogeneous, "varied in their intrinsic structure and in the structural and compositional characteristics induced by natural disturbance" (Franklin and Fites 1996).
Primary Criteria: Late seral condition is equated to structural complexity of vegetation, based on characteristics of mixed-conifer forest types: size and number of large-diameter trees (over 40 inches in dbh); cover of overstory trees and intermediate canopy levels; presence/absence of significant decadence in large live trees, levels of coarse woody debris, and patch disturbance history.
Method of Measuring/Inventorying: Retrospective resource-specialist experience; mapping at polygon scale, using aerial/satellite photographs, orthophotos, vegetation and habitat maps, etc. as aids.
Patches and polygons were ranked with regard to their contribution to late-successional/old-growth (LS/OG) forest function (structural complexity) according to a six-point scale ranging from 0 (no contribution) to 5 (very high contribution).
Geographic Scale(s): Sierra-wide, public lands. Emphasis on polygons (200-1000 acres); specialists mapped polygons based on grouping of patches (<200 acres, not mapped but scored for LS/OG type).
Forest Type: Emphasis on structurally complex types (mixed conifer and true fir), but the mixed-conifer structural complexity ratings and mapping were used to map all forests in the Sierra Nevada.
Disturbance: Information on all polygons was noted about wildfire, logging, mining, grazing, and recreation.
Management Extensions (from SNEP 1996):
(1) Areas of Late Successional Emphasis (ALSEs): Developed and mapped in considerable detail, this approach stratifies public land (focused on mid-elevation mixed-conifer and true fir types) into two categories: ALSEs and matrix lands. ALSEs are large landscape areas (20,000 - 60,000 acres) with management emphasis on maintaining structurally diverse forests. Areas with abundant high-ranked polygons are starting points. Achievement of goals at the rangewide scale depends on an integrated network of spatially explicit ALSEs and management of matrix forests across the range of the forest types. Matrix goals include promoting all forests toward at least LS/OG rating of 3.

(2) Distributed Forest Conditions: Minimally developed and not mapped, this approach features smaller areas of LS/OG emphasis managed in finer grain over the landscape than the above ALSE approach. Small- to medium-sized patches of existing or potential high-ranking LS/OG would be distributed over the landscape in a mosaic approximating pre-contact forest patterns. Management of old forest and matrix areas is emphasized as above; the primary difference is of scale and thus of more even distribution of old forest rather than aggregation in large ALSEs. The basic unit is the planning watershed (< 5,000 acres).

(3) Integrated Strategy. Developed and mapped for case study illustration on the El Dorado National Forest. This approach reconciles the needs for local implementation of any rangewide LS/OG approach, and attempts to integrate goals for old forests, vegetation, wildlife, watershed/aquatic, fire protection, community well-being, and private land contribution to ecosystem sustainability. "Watershed scale ALSEs" (intermediate between ALSE and Distributed Forest Conditions approach) are suggested, with integration of other concerns at the scale of about 14,000 acres.

(4) Simulations. SNEP developed a simulation model and ran 10 alternative approaches to forest management. Goals were integrated for old forests, fire reduction, riparian and watershed restoration, reintroducing historical (pre-1850) ecosystem processes, and timber. Forest structure goals were measured by rangewide standard LS/OG rankings (Franklin and Fites 1996). In applications to the Eldorado and Plumas National forests, late successional forests could be rebuilt by the model over the time periods of the simulations (50 years) following the "LS/OG, ALSE" strategy (Franklin and Fites 1996) while at the same time reducing susceptibility of severe fires. Other strategies except a 'no action' strategy also rebuilt late successional forests to high levels over the simulation period (Johnson et al. 1997).
Other: Two quality assessments of LS/OG polygon rankings were done independently in SNEP (Langley 1996 and Sessions et al. 1997) see bullet under Synopsis heading in OLD FORESTS section.

<u>SNEP: Structural Complexity: Series-Normalized Standards (1996)</u>

This approach by Franklin and Fites (1996) differs from the above in that the rangewide mixed-conifer standards of LS/OG polygon rankings were adjusted for the major forest types. This approach recognizes that there are "clearly major difference[s] in the levels of structural complexity that can be achieved among the different forest types...for example,...the most structurally complex lodgepole forest might only be rated as a 3 in a structural scheme based upon mixed-conifer forest" (Franklin and Fites 1996). A tabular "crosswalk" was developed for the structural complexity criteria, with adjustments made to accommodate differences among forest types.

<u>Sierra Biodiversity Institute 1990 (in Davis 1996)</u>

Primary Criteria: Spectral properties
Method of Measuring/Inventorying: Map produced based on 1990 Thematic Mapper (TM) satellite data. TM data with spatial resolution of 0.05 acres were classified into 2 classes (old forest and non-old forest) based on spectral properties of a large set of sites that were visited in the field and assigned to old forest or nonold-forest types.
Geographic Scale(s): Western Sierra Nevada, public/private lands; 0.4 acre resolution

Forest Type(s): Broad mixed-conifer zone with associated true fir and pine types.
Other: Comparison by Davis (1996) of this approach to SNEP LS/OG mapping (Franklin and Fites 1996) indicates similar amount of old forest on average in the Sierra Nevada, but no to low overlap in the location of areas mapped. Differences seem most likely due to the large difference in spatial resolutions used.

US Forest Service: Forest Inventory and Analysis; Ecological Classification (US Forest Service 1995, 1996, Beardsley et al. in press)
Definition: Ecological classification, varies by forest type
Primary Criteria: Old-growth definitions developed by team of ecologists based on stand age, size and density of large trees, size and density of large snags and logs, variation in canopy layers and tree diameters, presence of decay in live trees. Definitions were developed from quantitative analysis, using plot-based on ecological classification and sampling studies specific to each forest type.
Method of Measuring/Inventorying: National forest inventories conducted by Forest Inventory and Analysis (FIA) program (USDA Forest Service 1994). Vegetation was mapped by remote sensing methods and stratified into stands of 5 acres or more. 1,907 ground plots covering 2.5 - 5 acres measured species, dbh, height of trees and snags, downed logs, cover of shrubs, forbs, and grasses, and site index.
Geographic Scale(s): Sierra-Nevada-wide, US Forest Service lands, emphasis on stand level.
Forest Type(s): ponderosa pine, interior ponderosa pine, mixed conifer, white fir, red fir, Jeffrey pine, lodgepole pine, mixed subalpine types; studies indicated high variability in old forest conditions among forest types.
Disturbance: Not part of analysis
Management Extensions: None developed yet
Other: Beardsley et al. (in press) contains a summary of approaches to Sierra Nevada old forests and summaries of the individual definitions for old forests by forest type. Accuracy of remotely sensed maps, based on ground checks, was 80-90% at the level of life form and 75-90% at the level of CALVEG types (USDA Forest Service 1994). FIA plots were quality checked in the field and only those plots with 90% correct implementation (criteria set) were used. The report also contains a quantitative comparison of current inventory to the 1945 assessment of old forests. Moen and Gutierrez (1997) indicate that current satellite-image classification of Sierra Nevada national forests lacks information on large (^{3} 40 inches in dbh) residual trees that they showed were key habitat features for California spotted owls.

Spotted Owl Habitat, CASPO Interim Guidelines (Verner et al. 1992, US Forest Service 1995, US Forest Service 1996)
Spotted owl habitat is defined specifically for the habitat needs of California spotted owls, and is thus not intentionally an old-forest definition. It is summarized here because it overlaps with elements of old forests, it is confused with old-forest definitions, and it is sometimes used as a surrogate for old-forest definition.
Definition: Spotted Owl Habitat
Primary Criteria: Site characteristics for nesting, roosting, and foraging. Primary attributes are described for percent canopy cover, total live-tree basal area, total snag basal area, basal area of large snags, and downed woody debris, divided by nesting/roosting and foraging conditions. Moen and Gutierrez (1997) emphasize the importance of large (^{3} 40 inches in dbh) trees.

Method of Measuring/Inventorying: Diverse, based on ground surveys and studies of owl habitat and behavior.
Geographic Scale(s): Range of California spotted owls, primarily low- to mid-elevation, primarily west-slope Sierra Nevada, restricted to certain forest types. Home ranges vary considerably over the distribution of the owl and depend significantly on forest conditions of matrix lands surrounding owl sites. During breeding seasons, home ranges average 4,200-7,000 acres. Home ranges on average double in size during the nonbreeding period.
Forest Type(s): foothill riparian/hardwood, ponderosa pine/hardwood, mixed conifer, red fir, eastside pine (marginal habitat).
Disturbance: Current risk of unnaturally large and intense stand-destroying fires is considered a severe risk to owl habitat.
Management Extensions: CASPO interim guidelines currently in place on affected national forests are described in Verner et al. (1992) and US Forest Service (1995, 1996). Goals are to provide for key owl habitat by protecting known nest stands and large old trees, and reducing the threat of stand-destroying fire. No harvest is permitted in protected activity centers or of trees larger than 30 inches in dbh. Basal area, canopy-closure, snag and downed wood retention requirements exist for select Timber Strata (P4G, M4G, M4N, M5G, M5N, M6) and Other Timber Strata (M2G, M3P, M3G, M4P, R3P, R3N, R4G, R4N, P4N, P3G, P3N). See Verner et al. (1992:21-22) for strata explanation. Other management requirements protect riparian habitat, direct fuel and fire management, and contain direction on other habitat elements.
Other: Based on analysis by Franklin et al. (1997), the CASPO management guidelines (admittedly designed for owls) do not adequately protect landscape-scale blocks and networks of old forest, and do not incorporate ecosystem dynamics, but do provide partial spatial explicitness, connectivity, LS/OG restoration, and some matrix forest conservation.

<u>Other Wildlife Habitat: Carnivores</u>
The inclusion of other wildlife habitat concerns here is similar to California spotted owls. Habitat of certain carnivores, especially American martens and Pacific fishers, contains many elements that are considered to typify old forest. Vegetation descriptions for carnivores, however, are intentionally focused on the needs of specific species.
Definition: Carnivore Habitat
Primary Criteria: Primary elements vary by species, but emphasis is on specific levels for denning and foraging in forests with high structural complexity, including high canopy closure, conifer species composition and density, high basal area and multi-storied stands, specific density and species of large trees and snags/downed wood. Of these, overhead cover, large live trees, fallen large trees and stumps, and vegetation to support prey are considered critical. Proximity to dense riparian and wet areas as well, as to small openings, improves habitat quality.
Method of Measuring/Inventorying: Diverse, based on ground surveys and studies of carnivore habitat and behavior.
Geographic Scale(s): Distribution range and suitable habitat of species--elevations range from 3400 feet-13,100 feet, conifer forests Sierra-Nevada-wide for martens; elevation 2500 feet->10,000 feet conifer and conifer/hardwood forests Sierra-Nevada-wide for fishers. Home ranges are up to 4,000 acres for martens and up to 10,000 acres for fishers.
Forest Type(s): red fir, lodgepole, subalpine conifer, mixed conifer, white fir, ponderosa pine/hardwood, Jeffrey pine, and eastside pine (martens)
Disturbance: Fire risk to habitat similar to California spotted owls

Management Extensions: Fisher and marten habitat management areas are designated on five of the 10 affected national forests in the Sierra Nevada. In most cases these are created and connected via corridors using the recommendations in Freel (1991). This document is a collection of recommendations based on a workshop held in 1990 to gather the opinion of biologists who had experience conducting research on these species. Unfortunately, little information was available on the habitat ecology of fishers and martens at that time, and principles of the new field of conservation biology had only recently become incorporated into the field of wildlife biology. Forest Service, PSW Region, is currently soliciting information on specific criteria that each national forest used to establish their marten and fisher management areas and to encourage those forests that have no specific areas designated to do so. The Freel approach has been criticized for its reliance on habitat areas whose sizes are based on an artificial population subunit, among other reasons. Despite these shortcomings, completing the designation of management areas using the Freel criteria is necessary because this Sierra-wide network can then be overlapped with the distribution of other areas (e.g., ALSEs, goshawk management, spotted owl habitat) to create a starting point for plans to develop a new approach to conserve old-forest habitat for all species that depend on these forests. Although considerable new information has been or soon will be published on the habitat ecology and distribution of fishers in California, these data have not had a noticeable effect on management of these species. Finally, biologists have had available to them general habitat guidelines and ecological information in Ruggiero et al. (1994). Sections in this document on "management implications" provide general suggestions for habitat conservation and management, but the guidelines are general enough to apply to the entire range of each species in the western United States. Special recommendations for fisher conservation in California, and specifically in the Sierra Nevada, are not included.

<u>Lake Tahoe Forest Health Consensus Group (FHCG) 1998</u>
Definition: "Late successional refers to many attributes, including but not limited to: big trees, broad crowns, heavy limbs, decadence, and structural complexity" (FHCG Newsletter 1998)
Primary Criteria: Structural complexity of forest stands and also specific attention to individual large trees (greater than 30 inches dbh)
Method of Measuring/Inventorying:
Geographic Scale(s): Lake Tahoe Basin
Forest Type(s): Conifer forest types in the Lake Tahoe Basin "in which structural complexity continues to increase with stand age for at least several centuries and for which the ecological differences between late successional and earlier successional stages are distinctive."
Management Extensions: The FHCG recommends adding a LS/OG threshold as "Interim Ordinance for the Protection of LS/OG Trees" in the Tahoe Basin. The primary standard is to prohibit cutting of all live, dead, dying trees >30 inches in dbh and to promote characteristics of old stands (150-200 years old).

<u>Quincy Library Group (QLG)</u>
The QLG focuses on forest lands of the Plumas and Lassen National Forests, and the Sierraville Ranger District of the Tahoe National Forest, and on mixed conifer, white fir, red fir, eastside mixed conifer, eastside pine, and lodgepole pine. Structural complexity classes of Franklin and Fites (1996; rangewide standards) are used to evaluate old-forest condition.

APPENDIX 1, PART 2
FEMAT AND SNEP: A COMPARISON OF APPROACHES TO MANAGEMENT OF AQUATIC AND RIPARIAN SYSTEMS

I. Forest Ecosystem Management Assessment (FEMAT)

Background

In 1993, President Clinton convened a Forest Conference in Portland, Oregon to develop an approach to meet the needs of both humans and the environment on federal forestlands of the Pacific Northwest. One of the products of this effort was an Aquatic Conservation Strategy (ACS) (Forest Ecosystem Management Assessment Team [FEMAT]1993). The primary goal of this strategy was "to restore and maintain the ecological health of watersheds and the aquatic ecosystems contained within them on public lands" (USDA Forest Service and USDI Bureau of Land Management 1994). Nine objectives were outlined in support of that goal (Table 1). The ACS contained four integrated components: watershed analysis, key watersheds, riparian reserves, and watershed restoration. These components were meant to be implemented in a complementary fashion, as none alone would accomplish the goals and objectives of the strategy on its own. The components, as finalized in the USDA Forest Service and USDA Bureau of Land Management (1994) Records of Decision, are described below.

Aquatic Conservation Strategy

Watershed Analysis. Watershed analysis is used to understand the important ecosystem, landscape, and land-use processes in a watershed. It consists of compiling information on: resource issues and needs, natural processes and interactions, interactions between resource use and ecosystem condition and historic management activities, and other local watershed conditions (USDA Forest Service and USDI Bureau of Land Management 1994). Analysis of this information provides the critical link in an adaptive management approach for maintaining healthy watershed functions and processes.

Key Watersheds. A set of watersheds thought to be important for aquatic species (primarily fish) conservation is identified. The resulting network provides large protected areas (refugia) to maintain populations that connect and repopulate areas impacted by land management activities outside of the refugia (USDA Forest Service and USDI Bureau of Land Management 1994). Key watersheds that contain high quality habitat for aquatic species are assumed to be functioning as refugia at present, while lower quality areas are candidates for active restoration. Management activities can occur in key watershed only if a watershed analysis is done and shows these activities to be neutral or positive to aquatic ecosystem conditions.

Riparian Reserves. Riparian reserves are protected areas around aquatic habitats where the primary emphasis is on riparian-dependent species. They act as buffers between upland land management activities and aquatic ecosystems. Widths of riparian reserves are based on the type of aquatic habitat and the presence of fish. Lakes and fish-bearing streams receive the greatest protection. Reserve widths are based on the largest of the following distances: top of the inner gorge, outer edges of the 100-year floodplain, outer edges of riparian vegetation, distance equal to the height of two site-potential trees, or 300 feet slope distance (600 feet total). Interim

riparian reserve widths for permanent non-fish-bearing streams, constructed ponds, reservoirs, wetlands (acre), and intermittent streams receive less protection, approximately 100-150 feet slope distance (USDA Forest Service and USDI Bureau of Land Management 1994). Interim riparian reserve widths cannot be changed without a watershed analysis.

Watershed Restoration. The goal of watershed restoration is recovery of degraded fish habitat, riparian habitat, and water quality. Specific activities are designed following watershed analysis. The primary foci of restoration are to eliminate sediment production from roads, restore riparian vegetation, and improve instream habitat complexity (USDA Forest Service and USDI Bureau of Land Management 1994).

In essence, riparian reserves are intended to ensure that watershed processes capable of sustaining suitable aquatic habitat are themselves sustained; key watersheds are intended to sustain locally strong fish populations capable of repopulating recovering areas elsewhere; restoration is intended to speed recovery of impaired watershed function; and watershed analysis is intended to provide the level of understanding of local conditions necessary to allow implementation of the other three components.

II. Sierra Nevada Ecosystem Project

The Sierra Nevada Ecosystem Project (SNEP) approaches to aquatic and riparian management described below were derived from a variety of contributors; there is not one integrated strategy that was put forth for the Sierra Nevada. Nonetheless, when considered together, these parts provide an approach similar to the FEMAT approach described above.

Background

Aquatic and riparian ecosystems were the focus of more than 20 chapters in the Status of the Sierra Nevada report (SNEP 1996). Detailed assessments were provided for hydrology (Kattelmann 1996), amphibians (Jennings 1996), aquatic habitat types (Moyle 1996a), fish and fisheries (Moyle et al. 1996c), biotic integrity (Moyle and Randall 1996), aquatic invertebrates (Erman 1996), riparian and wetland habitats (Kondolf et al. 1996, Kattleman and Embury 1996), and terrestrial vertebrates that use riparian habitats (Graber 1996). The overwhelming conclusion from these assessments was that aquatic and riparian systems are the most transformed from original conditions of all environments in the Sierra Nevada. A variety of factors have contributed to this situation, including, in no particular order, dams, reservoirs, water diversions, road construction, timber harvesting, livestock grazing, alien species introductions, mining, water pollution, and recreational and residential development. While some of these habitat alterations are irreversible, many areas exist where conditions could be improved through positive management practices.

Tools for Research, Assessment and Monitoring

The importance of assessment, research, and monitoring as a foundation for land management strategies was emphasized by many authors in SNEP (e.g. Kattelmann 1996, Kondolf, et al. 1996, Erman 1996). Several chapters in the SNEP reports provide useful methods for evaluating the status and trend of aquatic and riparian system conditions. These methods include a classification

system for aquatic habitat types (Moyle 1996a), quantifying watershed condition using GIS (Costick 1996a), cumulative watershed effects assessments (Berg et al. 1996), and a variety of modeling techniques (Marvin 1996, Ustin et al. 1996, Menning, et al. 1997). Two case studies offer examples of the use of models to predict changes in hydrology and sediment regimes under differing land use scenarios (McGurk and Davis 1996, McGurk et al. 1996). The case study of the Lake Tahoe Basin might serve as a template for an adaptive management approach for aquatic and riparian systems in the Sierra Nevada (Elliot-Fisk et al. 1997). This study demonstrated that integrating current knowledge of ecosystem dynamics with evaluation of past management practices can result in successful new management strategies.

Strategies

The SNEP reports offer two primary goals for improving watershed condition and aquatic biodiversity: (1) "Improve the biotic integrity and sustainability of aquatic habitats and ecosystems in the Sierra Nevada. This goal implies the protection, management, and restoration of watersheds to maintain natural hydrologic and ecological processes." (2) "Secure long-term social and economic benefits of a dependable supply of clean water from naturally functioning watersheds" (SNEP 1996 Vol. I).

Moyle et al. (1996a) summarize more specific goals for riparian management from a variety of Federal and private sources in the Sierra Nevada (Table 2). They also provide a rating system for management of riparian areas and potential interim management prescriptions for the Sierra Nevada. The recommended strategies for meeting these goals were to: (1) have a watershed focus, (2) protect the least degraded areas (reserves), (3) improve land management practices, (4) restore natural stream-flow patterns and native species of plants and animals, and (5) make a long-term commitment to monitoring (SNEP 1996 Vol. I). Below we describe approaches (1)-(4) in more detail; monitoring is addressed in a more general context earlier in the Science Review.

Watershed Focus and Protection of Less Degraded Areas. A watershed-focused management approach highlights connections between upstream and/or upslope environments and the condition of adjacent riparian and aquatic habitats (SNEP 1996 Vol. I). In the Sierra Nevada, identification and appropriate management of aquatic diversity management areas (ADMA watersheds) was recommended as an important component of an overall plan for improvement of aquatic/riparian resources (Moyle 1996b, Moyle et al. 1996b). A watershed-based approach was also used to identify potential techniques for selecting biodiversity management areas for native plant communities (Davis et al. 1996). The ADMA approach falls in the middle, in terms of likelihood of implementation and long-term conservation value, of a suite of approaches devised by Moyle and Yoshiyama (1994). ADMA watersheds have protection of aquatic biodiversity as the primary management goal. Watersheds are identified as ADMAs based on the following characteristics: size (> 80 $mile^{2}$), presence of a natural hydrologic regime, dominance of native species, wide representation of aquatic habitat types, terrestrial and riparian ecosystems are in relatively good condition, and any other characteristics that make them unique (Moyle 1996b). Significant Natural Areas (SNAs) have unique biota or other characteristics but are too small to be designated as ADMAs. The emphasis in these areas is preservation of biodiversity and they act as supplements to adjacent ADMAs (Moyle 1996b). While land management within ADMAs is

focused on sustaining aquatic biodiversity, other activities are possible if an effort is made to minimize negative impacts on diversity (see Moyle 1996b: Table 57.4).

Improving Land Management Practices -- Land Use Buffers. Another important strategy for conserving aquatic and riparian ecosystems was land use buffers (Kondolf et al. 1996). Buffers that are based on identifying the area relevant to stream, lake, or wetland processes and functions will maintain these systems. Thus, the strategy for designing land use buffers defines three areas which can vary substantially from watershed to watershed. The community area includes the aquatic and riparian habitats necessary for the maintenance of flora and fauna dependent on these habitats. The energy area includes upstream, riparian, and upslope areas that contribute organic material and energy. The land-use influence area includes upstream and upslope areas that influence aquatic and riparian habitats (Kondolf et al. 1996). Land use buffers for riparian habitats are calculated using a formula that starts with the area encompassed by either the community or energy area (whichever is largest) which is multiplied by the natural logarithm raised to the power of a slope factor. An additional soil erodibility factor can also be included (Kondolf et al. 1996). If this buffer area is considered a "probability of disturbance area" and managed according to local sensitivities, vital aquatic riparian processes and functions should be maintained.

Restoration. Recovery of less degraded watersheds and the species that historically inhabited them can be accomplished through restoration (Jennings 1996, Moyle and Randall 1996). Active restoration of plant communities and native fish and wildlife species was recommended by several SNEP authors (Kondolf et al. 1996, Kattelmann and Embury 1996). However, these same authors cautioned that restoration should target the causes of degradation, rather than current methods which often focus on "the symptoms." Restoration of natural variability of stream flows was suggested to be an integral part of any approach to restoring physical and biotic components of aquatic ecosystems (Kattelmann and Embury 1996).

III. Comparison of FEMAT and SNEP

The main components of FEMAT and SNEP approaches to aquatic and riparian management are similar; they differ mainly in the details, including terminology. Both assessments suggest a watershed focus and propose reserve areas (FEMAT Key Watersheds and Moyle's (1996b) Aquatic Diversity Management Areas). While SNEP does not specifically identify "watershed analysis", there are several chapter that provide the tools needed to do such assessments (see section above, "Tools for Research, Assessment, and Monitoring". The two approaches to reserves differ somewhat. FEMAT Key Watersheds are chosen primarily because they contain at-risk fish stocks and either good habitat or poor habitat that has a high restoration potential. Proposed ADMAs would be chosen with the goal of representing aquatic habitats that are in reasonably good condition and contain populations of all native aquatic species (not just fish).

Both assessments also provided guidelines for designating land use buffers (SNEP) or riparian reserves (FEMAT). Again, the difference lies in the details of how the widths of these areas are derived. FEMAT provides a variable width system based on presence of fish, aquatic habitat type, and water permanence with the use of watershed analysis to provide the information needed to tailor riparian reserve design to the specific needs and opportunities present in specific watersheds. SNEP authors seem skeptical of this approach saying that buffer widths that are

based on water permanence, presence of certain biota, size, or set arbitrary widths, do not fully address the connected nature of aquatic systems or the needs of riparian-dependent species and cannot adequately protect the unique and variable biotic and abiotic characteristics of individual watersheds (Kondolf et al. 1996). Instead, SNEP offers an approach based on three areas of ecological processes (community, energy, and land-use influence) and offers a mathematical formula for deriving buffer widths, based on observations of these areas.

Finally, both assessments recommend active restoration to improve the health of aquatic and riparian ecosystems, though their focus differs somewhat. FEMAT emphasizes reducing sediment and improving instream habitat complexity and SNEP emphasizes restoring natural stream-flow regimes (amount of water). Both put restoration of riparian vegetation as a high priority.

An integrated component-approach, like that of the FEMAT Aquatic Conservation Strategy could also be applied in the Sierra Nevada. This integration is missing from SNEP because of SNEP's origin as a compilation of documents from multiple authors. However, a comprehensive aquatic and riparian management approach could be developed for the Sierra Nevada through integration of the strategies proposed by SNEP authors. Other recent scientific assessments may also offer additional strategies for aquatic and riparian conservation, for example, the Interior Colombia River Basin Assessment and EIS (Quigley et al. 1996, USDA Forest Service and USDA BLM 1997)

Table 1. Aquatic Conservation Strategy (FEMAT) objectives for Forest Service and Bureau of Land Management lands within the range of the northern spotted owls (from USDA Forest Service and USDI Bureau of Land Management 1994a).

1. Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.

2. Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.

3. Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

4. Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.

5. Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.

6. Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.

7. Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.

8. Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of course woody debris sufficient to sustain physical complexity and stability.

9. Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species.

Table 2. Some general goals for management of riparian systems. Not listed in order of importance (from Moyle et al. 1996a).

Goal 1. Identify and provide special protection for unusual/rare aquatic and riparian habitats and for rare, threatened, and endangered species that require riparian areas.

Goal 2. Maintain and restore wherever possible continuous corridors of riparian and upland habitat along streams for wildlife movement and migration.

Goal 3. Identify riparian areas that are in the best condition (i.e. areas dominated by native species, with most natural ecosystem structure and processes intact) and give such areas the highest priority for formal protection and intense management.

Goal 4. Maintain water quality parameters (temperature, sediment load, pH, etc.) in associated water bodies within the natural range of variability for each water body.

Goal. 5. Maintain or restore stream channel, pond, lake, and wetland ecological integrity and natural processes to within the natural range of conditions.

Goal 6. Maintain or restore stream channel or subsurface flows to levels that (1) support the natural riparian and aquatic biotic systems and that (2) maintain the natural functions of stream channels and aquifers.

Goal 7. Maintain or restore the natural elevation , size, and lateral extent of subsurface water in meadows and wetlands.

Goal 8. Maintain or restore the natural structure, diversity, and productivity of native riparian plant communities.

Goal 9. Maintain or restore stands of large riparian trees in order to provide large woody debris for instream habitat.

Goal. 10. Maintain or restore riparian corridors to support well-distributed populations of plants and animals that depend on riparian and aquatic habitats for their movements and long-term survival.

APPENDIX I, PART 3: GRAZING

SUGGESTED ADDITIONAL PRIORITY ISSUE FOR SIERRA NEVADA CONSERVATION

Issue: GRAZING (Domestic Livestock and Packstock)

Synopsis

* Eighty-nine percent of the vegetated land in the Sierra Nevada is estimated to be available to grazing (Davis and Stoms 1996). Grazing by livestock appears to have been virtually ubiquitous in the Sierra Nevada from the early 1800s through 1930 (Dudley and Embury 1995, Kattlemann and Embury 1996, Kinney 1996, McKelvey and Johnston 1992, Menke et al. 1996). Reference conditions (ungrazed) are lacking (Elmore and Beschta 1987, Kattlemann and Embury 1996, Menke et al. 1996). Effects on aquatic/riparian areas are a principal effect of certain livestock grazing practices, especially historic overgrazing, in the Sierra Nevada (Chaney et al. 1993, Erman 1996, Jennings 1996, Kattlemann and Embury 1996, Kondolf et al. 1996, Moyle et al. 1996). "The interrelated impacts commonly attributed to overgrazing include vegetative cover, changes in species composition, introduction of exotics, reduction or elimination of regeneration, compaction and cutting of meadow sod, depletion or elimination of deeply rooted vegetation that strengthens banks, loss of litter and soil organic matter, erosion of stream banks, beds and flood plains, loss of overhanging streambanks, destabilization of alluvial channels and transformation to wide shallow channels, initiation of gullies and headcuts, channel incision and consequent lowering of water tables, desiccation of meadows, increased water temperature during summer due to reduction of shade, increased freezing in winter from reduction of insulation and snow trapping efficiency, siltation of streams, bacterial and nutrient pollution, and decline of summer streamflow (Kattlemann and Embury 1996, pg. 219, citing other references).

* Grazing is related to extirpation of Least Bell's Vireo from the Sierra Nevada (Graber 1996, Small 1994); to declines of willow flycatchers (Gaines 1988, Harris et al. 1987, Harris et al. 1988, Serena 1982), great gray owls (Gaines 1988, Graber 1996) golden trout (Moyle et al. 1996, Lahontan cutthroat trout (Moyle et al. 1996), several native amphibian and fish species (Armour et al. 1991, Jennings 1996, Jennings and Hayes 1994, Lind et al. 1996, Moyle et al. 1996, Platts 1991) and bighorn sheep (Foreyt 1994, Foreyt et al. 1994, Hunter 1995, Jaworski et al. 1993, SNBSIAG 1997); to increases in alien annual grasses such as cheatgrass (*Bromus tectorum*) (Menke et al. 1996) and other plant species such as star thistles (*Centaurea* spp.) (Dudley and Embury 1995, Schwartz et al. 1996); and to invasion by brown-headed cowbirds (Graber 1996).

*"Impacts of overgrazing are considered second only to dams and river regulation as a cause of degradation of riparian areas in the Sierra Nevada foothills" (cited from Kattlemann and Embury 1996, pg 218; Nelson et al. 1994). Foothill habitats have experienced widespread replacement of native perennial flora by Eurasian annuals and transformation of ecosystem function that is associated primarily with introduction of grazing (Graber 1996, Standiford et al. 1996).

*At mid- to high-elevations, historic livestock grazing significantly impacted riparian areas, meadows, and other wetlands (Kinney 1996). Following intense historic (1800s/early 1900s) overgrazing, many mid- to high-elevation meadows have been eroding, with some small meadows completely lost. Channel cutting altered the hydrologic condition of many meadows with the

overall result that they are being transformed from sites of sediment deposition and storage to sources of sediment, and many plant communities changed from wet to dry types. The relative contributions of early domestic grazing and natural climate change in the last 200 years (which resulted in similar environmental effects, Wood 1975) to these landscape effects is poorly understood. (Summarized from Hagberg 1995, Kattlemann 1996, Kattlemann and Embury 1996, Kondolf et al. 1996, Moyle et al. 1996c.)

* Grazing uplands has led to widespread invasion of cheatgrass, an aggressive alien that is causing an ecological transformation that is unlikely to be reversed. Cheatgrass invasion persists despite reductions in grazing intensity (Menke et al. 1996).

* Following cessation or control of grazing, restoration of vegetative cover in riparian areas can be relatively rapid (years to decades--Chaney et al. 1993, Nelson et al. 1994, Odion et al. 1990), but recovery of geomorphic structure and function and of riparian and aquatic biodiversity appears to be on the order of decades to centuries (Dudley and Dietrich 1995, Herbst and Knapp 1995a; 1995b, Kattlemann and Embury 1996, Kondolf 1993, Kondolf and Micheli 1995, Menke et al. 1996, USDI Bureau of Land Management 1994).

* Trends noted in Sierra Nevada rangelands primarily reflect the effect from decades of extremely intensive use starting in the mid-1800s. Use has only recently been reduced substantially and in the past 5-7 years active management changes have been made to favor resource protection; variable recovery trends (e.g., increases in native perennial grasses) suggest that reductions can lead to restoration of some geomorphic function (Elmore and Beschta 1987, Overton et al. 1994) and biodiversity (Kondolf et al. 1996, Menke et al. 1996, Overton et al. 1994) although increases in cheatgrass continue (Menke et al. 1996).

* Sagebrush-steppe communities of the eastern slope have been highly altered due to heavy grazing historically. Primary alteration has been loss of native perennial grasses, increase in sagebrush and alien annual grasses, especially cheatgrass, and an increase in fire frequency (Kinney 1996, Menke et al. 1996).

* For westside forests, grazing in the late 1800s was associated with the reduction of fires as recorded in tree rings. This is thought to result from reduction of fine fuels to carry fires and also may have contributed to ingrowth of young trees in subsequent decades (Skinner and Chang 1996).

Additional References: Wills and Sheehan 1994.

Basis for Inclusion

* Grazing by domestic livestock is considered to have affected more area in the Sierra Nevada than any other management practice except perhaps fire suppression (Davis and Stoms 1996, SNEP 1996, Vol. I). Impacts have been in areas of high biological diversity and sensitivity. Significant declines in grazing amount, and management focused on resource protection, began only within the last 10 years or so on most national forests.

* Many modern grazing practices and mitigation show potential to yield rapid recovery of specific ecosystem elements, while other areas of ecosystem function have not responded yet to changed practices.

Geographic Region of Concern

* Highest priority to areas where grazing directly affects resource concerns: riparian ecosystems, water quality, water tables in meadows, and ranges of species of concern, such as bighorn sheep disease transmission, willow flycatcher habitat, Yosemite toad and mountain yellow-legged frog habitat,

Primary Scales for Consideration

* Rangewide focus, implementation at scale of local allotments; specific concern focused on aquatic, riparian, wetland, and meadow habitats.

Relationship with National Forest Management

A. Reference above Synopsis:

* What forest service programs might be emphasized that favor consistent implementation of grazing regulations, monitoring, and adaptive management across national forests?

* What steps could be taken to control brown-headed cowbirds in areas where invasions are progressing rapidly and parasitism of native bird nests is likely?

* What actions might help to slow the flow of invasive plants onto national forest lands?

* How might improvements be made in assessing fair payment for use of federal lands for grazing, and optimize return of funds to national forests for local management?

B. Reference other issues in this report:

* What steps could be taken to improve the effectiveness of buffers to limit and alleviate contact between domestic sheep and bighorn sheep populations? [See Issue on BIGHORN SHEEP.]

* Do current forest plans adequately emphasize minimizing the effects of grazing on terrestrial (especially riparian and meadow) and aquatic biodiversity conservation? [See Issues on AQUATIC, RIPARIAN, AND MEADOW ECOSYSTEMS.]

APPENDIX II: REVIEWER'S COMMENTS

This report received broad exposure and review by many members of the public and the scientific community; this resulted in hundreds of comments and recommendations to the Science Review team. It was also subjected to a formal, blind peer review by eight scientists representing a range of organizational and scientific interests. Comments of these eight scientists are presented in the following section.

Review Comments
Blind Peer Review, July 10, 1998 Draft

Reviewer 1of8:

It was difficult to review this without the specific citations tagged to the bullets. It made it impossible in many sections to determine the strength of the supporting documentation for any given statement.

It was difficult to know what the final format was going to be. I liked the relationships to management as questions rather than statements of findings and I did not think there would be recommendations on what to do management-wise in this section such as how to manage grazing specifically. I don't think you can safely make specific management recommendations at a broad scale.

Issue: Old Forest Ecosystems (1) Forest Conditions of Structurally Complex Forests.
On the bottom of the page 4, in the bullet "Loss of density of large diameter trees..." are you really saying the study forests were unlogged, ever? In the same section page 6 under Geographic Region of Concern includes "including associated riparian elements" is this clear from the science? What exactly is meant by it? All the findings fit everywhere? All the science findings are for both upslope and riparian forests the same. This is difficult to believe and you have not provided any convincing case for this argument.

Fire in general - the statements in each different section should be cross referenced to be consistent or explain why they are not. For instance, the fire section makes it sound like the subset of findings fits everywhere and then the owl section cites science saying things are different in different forest types and at different elevations.

Under the 3rd bullet, Issue: Aquatic Riparian... (1) Low to middle Elevation. Sentence construction makes meaning of the statement unclear.

The multiple use of the bullet "* Current characterization of riparian corridors that treat them as uninfluenced by fire...." Where do you get this from? What papers are saying this? Please see the 2 references Rieman and Clayton 1997 and Rieman et al 1997. I think this statement is misleading.

Issue: Riparian (1) Low to Mid (under Scales): What about fine features? Some of what we know least about are seeps, springs, etc. See Columbia River Basin Aquatic Science document discussions.

Issue Aquatic Riparian... (3) Grazing. First bullet in synopsis - use of "freezing". Do you mean increased possibility of anchor ice or frazzle ice formation in streams or do you mean to indicate the stream or lake or whatever freezes solid?

Issue Aquatic Riparian (5) Willow Flycatcher. last bullet - are you sure about making the statement "clear cut timber harvest on nearby slopes"? Are these old ones or new ones? - it is not clear what is being implied.

Issue Old Forest Ecosystem (X) Northern Goshawk Question: -does this include the latest accumulation of information by the USFWS used to make their recent determination?

Under Part B (Northern Goshawk) #3 fire & fuels - How should this be best implemented on the landscape (spatially?, time phasing treatments?) to meet conservation biology objectives.

There is not much indication that there is a difference in the potential for fire and fuels management in riparian vs upland forests. For research on trade-offs or approaches, see CRB science documents, Rieman and Clayton 1997, Rieman et al. 1997. What they are saying and finding is very relevant to this discussion.

No science is referenced from the "Integrated Science Assessment for Ecosystem Management in the Interior Columbia Basin and Portions of the Klamath and Great Basin" Quigley, Haynes and Graham editors, PNW-GTR-382, Sept 1996. Or any other GTRs from the CRB. I think you are missing a lot by not looking at these documents and bringing in that science is critical for strengthening any product to come out of the Sierra Nevada effort.

Discussion of SNEP and femat Riparian Approaches.
*See some specific comments on the document
*Clarity is important if what is being compared is FEMAT ACS or the ACS as modified in the EIS and ROD for the Northwest Forest Plan.
*The FEMAT Science was used but the EIS processes resulted in modifications - e.g. final buffers moderated by concerns about PSQ.
*SNEP later version that built on Science but also incorporated knowledge about system differences and science from Sierra Nevada (e.g. published data on the role of intermittent streams and ephemeral channels).
*The CRB science documents have a thorough discussion of both approaches that should be read by your team before the draft is finalized. It does not pose the discussion as a FEMAT vs SNEP - In fact there are many other aquatic strategies out there -see the CRB Aquatic Science Report for a review/comparison of about a dozen different ones. The Draft Eastside EIS poses different alternatives using both SNEP and NWFP buffer delineation approaches.

It may be misleading where only certain or some subset of findings of SNEP are highlighted in this document. It could give the reader the impression that the scientists support some but not others. This needs to be clarified. What does it mean if some findings are left out? Are they not important?

Some issues where there appears to be no newer science than was in SNEP should just simply state that rather than repeating it. - this seemed to be the case in the demographic or socioeconomic changes section. It might be better to say that there are no new additions to the science rather than selectively reiterating from SNEP findings.

Unresolved issues section (Issues for further clarification) FEMAT vs SNEP is not the issue and it appears the evaluation of the background and common themes of ACS's is not really known to the authors - suggest reading CRB synthesis PNW-GTR-405 VOL III, June 1997, pages 1354 -1374 at a minimum.

I don't think that the fire issue is resolved and it should probably be discussed in the unresolved issue section as well. Specifically, the role of fire in riparian vs upland and strategies for restoring the role of fire in uplands vs riparian, as well as strategies for restoring the role of fire and what tools are appropriate when and where.

The Issues: Fire & Fuels section does not bring any clarity to the issue of potentially different effects, responses, states, implementation concerns etc. of riparian vs upslope forests. See discussions from CRB Science Rieman & Clayton, 1997 & Rieman, Lee, Chandler, & Myers 1997

OTHER RECOMMENDATIONS

1) In using references, differentiate somehow between peer reviewed science papers and those that were not (especially relevant for SNEP documents for instance).

2) In the discussion, differentiate what has been tested and substantiated vs. what is speculation and/or a suggestion for testing.

3) Provide context for what we know as well as what we clearly don't know. Is it in general across a large space or only tested for some types in the same areas. This will be helpful in gauging risk later on.

4) Citations should be linked directly to the statements they support.

5) Approach to relationship with National Forest Management:
- The significant questions posed in the Owl and goshawk, as well as Roads section, were more helpful than the bullet findings that were a selection of sources, but not all SNEP findings.
- Differentiate where things are effectively known and tested treatments vs. untested ideas;

- Are you or are you not making recommendations? - be specific; be consistent - It says in the Priority Considerations for Implementation you were not charged to recommend specific conservation goals or objectives, nor to outline management strategies or solutions. - Some sections appear to cross this line.

6) One of the greatest needs is some insight into how all the disparate parts would/could be put together into an ecosystem strategy through integration during the development (see what you say on p. 9, first full paragraph). References and discussion of the literature on this topic might be particularly useful. Discussions from the CRB science are some of the best available at this point.

7) Peer reviewed science findings should be differentiated from non-peer reviewed science. For example, some SNEP reports went through a blind peer review process and others did not (e.g. Kattleman and Embury did not while Kondolf et al. did).

8) As a further collaboration of point 6 (above), the Upper Columbia Basin EIS based on some of the CRB science finding is evaluating spatial prioritization and more spatially explicit plans. To provide a synthesis of this science to the Region would be extremely useful. I am surprised that it did not come up as an issue. The issue of spatially explicit information for evaluation and planning came out of California Spotted Owl FAC Report as well.

9) A choice was made by your team to not deal with a long list of species, however, this has been a consistent dilemma. It was for the NWFP, CRB, and the Owl DEIS. Is there any new science/solution approaches for management when long lists of species are in trouble? Forest Service may not legally be defensible in not dealing with all the species. I think everyone is dying for some insight or a new approach. Maybe the Choice of Species is all that the PSW Scientists can do for this, but it is disappointing. At least discuss whether or not there are any solutions out there. Are there?

10) Under Scales, discuss the potential of spatial prioritization or some other solution to the expectation that everything is done everywhere the same and at the same time. Implementation or prescriptions should probably differ in time and space. Some insight is desperately needed here.

11) When referring to the Sierra Nevada, use Sierra Nevada, not Sierras, Sierra, Sierran etc.

12) Some sections appear to have what is easier to see as new science in them - the owl and goshawk sections for example. Should that be the standard for all the similar sections?

Reviewer 1of8 Addendum:

Re: Review of the Sierra Nevada Science Review...Report of the Science Team charged to synthesize new information of rangewide urgency to the national forests of the Sierra Nevada, "USDA Forest Service, Pacific Southwest Research Station, Draft, July 10, 1998.

Additional Remarks:

The Forest Service and the Bureau of Land Management have been sued over numerous failures with the Northwest Forest Plan, primarily related to the following:

(1) "survey and manage" species protocols and implementation,
(2) the effectiveness monitoring program for water quality; and
(3) certain other items that may have been mentioned in the lawsuit.

The legal action and steps taken to resolve this controversy in the northwest may have implications for Forest Service planning and management in the Sierra Nevada, vis a vis the items listed above. I recall no explicit discussion of this issue in the report. Given the significance of these items, it is essential that such information be considered by scientists, planners, and managers at the earlier possible opportunity.

Thank you again for the chance to review and comment on this report.

Reviewer 2of8:

General Remarks:

First, the report's summary of the recent fundamental scientific information likely to affect national forest management, already represents a fine effort to fulfill the task of "identification" that is part of the charge to the Science Team. This compilation, brief as it is, will represent a valuable contribution, both to the Forest Service planning effort and as a reference to the present state of scientific knowledge about the Sierra.

Second, I do appreciate but do not specifically discuss many instances where the report does a thorough job of discussing recent scientific findings and their implications. I commend the authors for doing an excellent job on many points, most of which I will not mention at all.

Third, discussion of implications for management of certain scientific information omits, in some cases, pertinent implications. The summary nature of this report not withstanding, some implications are not explicitly included, even where it is appropriate to draw such a conclusion from information as presented. I offer a selection of examples below.

Whether the omissions mentioned above were because this report is a preliminary aspect of a more detailed planning effort to come, or because they were simply overlooked, or because they were not deemed appropriate, is unknown to this reviewer. In some cases, further implications arise from the included information. In these cases, some discussion is in order. (See comments below.) These omissions appear likely to directly influence management decision making, and therefore appear to be within #1 of the charge to the Science Team, which directs the Team to develop a report that:

> "Identifies new scientific information not available during the formulation of existing management direction and its implications for resource management, conservation, and environmental and socio-economic conditions, and which, from a scientific stand point, bears on the adequacy of existing management direction for national forests in the Sierra."

Specific Comments:

** Demographic And Socioeconomic Changes*

Nowhere in this section do I find acknowledgment of the contingent nature of Forest Service plans and prerogatives. Yet, a review of Forest Service and other public natural resource programs, their funding and implementation, both over time and at the current time, suggests that, increasingly, uncertainty and change, rather then durability of agency mission and institutional stability, are the order of the day. Certainly this is true for the Forest Service and other resource related institutions in the Sierra. This relates to the Forest Service's ability to deliver on the commitments made in planning, including a wide array of resource management activities and monitoring. Institutional constraints--legal, budgetary, political, social and organizational-- have profound effects on an agency's ability to implement its own decisions, plans and programs, as well as the flexibility it may have to adapt to changing circumstances, or its ability to innovate, or, simply (and significantly). Equally, these constraints may impair an agency's ability to function in a management environment increasingly defined by collaborative arrangements. If these constraints have the potential to arbitrarily nullify Forest Service initiatives designed to respond to the scientific information adduced in this report, surely this information bears observation by Forest Service planner and administrators as well as public officials. These variables are critically important in the implementation of a variety of crucial resource stewardship programs intended to respond to scientific issues and concerns.

The success of these programs is contingent on many factors outside the control of the Forest Service is an important one, and should be discussed so that officials and interested parties consider the consequences of constructing malleable resource management policies and funding arrangements often not commensurate with the management responsibility. Perhaps it would lead to a constructive discussion of alternative designs for funding, collaboration, project implementation,

etc. Also, note that there is no real mention or adequate discussion of the difficulties inherent in "constructing collaborative efforts," let alone implementing them.

** *Fire and Fuels*

"The number of fire-fighting resources has been steadily declining since the mid-1970s and social, economic, and biological factors are making all aspects of fire management more costly"

I agree with the general sense conveyed by the statement, but would clarify by changing the word number "number" to terms indicating specific declines in resources, amounts, etc. Also, I would be careful to indicate that there are certain new and cost effective technological developments. However, these innovations have has not been enough to counter act the general overall trend of lower levels of fire fighting resources, coupled with higher costs.

*** *"Old-Forest Ecosystems* (Forest Conditions of Structurally Complex Forest Types)"

This section contains a succinct summary of a great deal of complex information, including a good discussion of (a) inconsistencies of the several more comprehensive efforts at old growth classifications and mapping (SNEP, Beardsley et al. 1998, etc.); (b) uncertainty of location; and (c) problems due to lack of precision and accuracy of mapping methods that now exist. Beyond raising several valid but relatively general scientific questions, however, neither this section nor a later section (entitled "Approaches To Defining and Measuring Old-Forest Ecosystems,") clarifies certain significant implications that must be considered. Neither section offers a rigorous treatment or reconciliation of the results of the plethora of studies something that may prove crucial determining the nature and location of stewardship of these resources and of future management activities in these areas; e.g., structural restoration, fuels management, etc.

Similarly, there little mention or discussion --let alone reconciliation or refutation-- the different perspectives on the nature and persistence of old growth (such as those of Bonnicksen and others) and their implications for management. In-depth exploration of this last issue, of course, may be beyond the scope of a rapid science review. Nevertheless, such views, whether entirely credible or not, persist, and cannot be altogether ignored.

The authors of the report may believe the former matter (lack of certainty, etc.) has been disposed of by the most recent study (Beardsley), or possibly that planning efforts after the completion of this report will address the issue. The lack of a clear direction on how the FS is to identify and locate old growth resources, however, is a matter of considerable importance. Without a forthright approach, that addresses this set of issues, smoldering controversies will remain unresolved, and controversial. During the various studies mentioned in the text, the Forest Service has already identified and located large portions of the existing old growth. At the same time, reading the bullet points in the synopsis tends to indicate that further research may still be required; e.g., surveys to establish with accuracy and agreement the location of old growth. One can't be sure from the report. From a scientific perspective, however, there is no question that it is essential to know which forest areas or stands constitute old growth, and why, and where they are located, before the adoption of standards and guidelines, let alone prescriptions, and detailed management plans.

Variations in the existing definition, classification and mapping techniques, suggest that establishing the boundaries and location of old growth resources with certainty requires some kind of reconciliation of the existing studies needs to occur. Has this occurred? From the text of the report, it does not appear so. Achieving this objective of reconciliation makes it far more likely that the new planning effort will address all significant aspects of this problem, including the nature and location and boundaries of old growth, and other ecologically important structural aspects. Practically, this initiative should occur before development of management prescriptions to make it possible to accurately assess future impacts likely to arise from eventual management actions, or to do so as they are discovered.

A large number of ecosystem attributes apparently depend or relate to old growth forests in some manner. Similarly, there are a number of management concerns or prescriptions pertaining to old growth. Given these points, location of old growth resources becomes fundamental to management decision making, not just for old growth, but to many other aspects of national forest planning.

**** *"Reinvestment & Funding For Ecosystem Management"*

As in the section on *Demographic And Socioeconomic Changes* I believe this adds an important dimension to the discussion. Under the discussion of funding, I would make it clear that there are several possible implications of current trends (lack of dollars for reinvestment, increased costs and the possibility that resource related revenues will decline into the future). Namely, one of the most significant is that there will be less funding available and thus fewer resource management activities, even those important to ecological health, recreational opportunities, and perhaps even to public health and safety

Reviewer 3of8:

Comments on Sierra Nevada Science Review Draft
July 17, 1998

Background:

Below are my comments about the Sierra Nevada Science Review Draft. I have been away from my office this week, so my comments are not supported by detailed references, nor have I been able to refer back to specifics of the original SNEP report. I start with some general comments, then follow with some more specific remarks. I have spent most of my time on the issue with which I am most familiar: AQUATIC, RIPARIAN, AND MEADOW ECOSYSTEMS: (3) GRAZING (Domestic Livestock and Packstock). This is also one of the most poorly developed issues in the Draft.

General comments:

1. I was very disappointed that the science team chose not to use the ecosystem framework for organizing and defining the issues. If an ecosystem framework is not practical for organizing, discussing, and assigning priorities for these tasks, then what does that say for the utility of the highly touted USFS ecosystem management approach? In part, the decision to use a "mixed" approach has led to a list of program priorities which is uneven in its treatment and difficult to compare rigorously among issues. The SNEP report developed a good basis for future effective application of ecosystem-based planning, but this appears to have been derailed in the Science review, which frequently falls back on species-based problem analyses.

2. To effectively improve the sustainability and health of Sierra Nevada ecosystems, this planning effort must explicitly link biophysical environmental issues at multiple scales. Without explicit inclusion of predicted changes in the physical environment, such as climate, cures aimed at protecting biodiversity are going to fail.

3. The assumption that the science review team would focus on new information is good. However, the SNEP report is uneven in its treatment of,the available information. Some chapters are excellent and up-to-date reviews supplemented with good new information. But, for example, the SNEP grazing chapter is a mixture of published scientific facts which are generally derived from review of mostly old secondary, not primary sources, newly gathered primary information for meadows, and unsubstantiated opinion about likely plant and system response to grazing. Issues such a fire in forested systems, spotted owls, and some other species-specific topics are well-covered and just need updating. Others, especially grazing, are inadequately covered initially, and thus need both updating and fundamental upgrading with inclusion of other information.

4. The science review would have benefited from an effort to develop and define realistic management goals and criteria for evaluating effectiveness of efforts to achieve those goals. Perhaps this can be included in a later step.

5. Many of the issues raised should be linked through regional air quality and regional and global climate change. How are the specific issues raised affected by the sharp changes in regional climate expected over the next few decades? This major issue cannot be effectively addressed without either adopting an ecosystem framework of developing this as a specific issue. There is generally an inadequate treatment of physical environmental issues.

6. The attempts at explicit delineation of appropriate spatial scales and links to management are to be applauded.

Specific comment, fire:

1. The fire issue contains no mention of grazing/fuel interactions after the first paragraph. Fuels in riparian systems have direct links to grazing. In foothill systems grazing/ fuel interactions are likely to be very important. The section has little information on systems outside of coniferous forests.

Specific comments, AQUATIC, RIPARIAN, AND MEADOW ECOSYSTEMS: (3) GRAZING (Domestic Livestock and Packstock).:

1. The grazing section mixes a series of comments and problems that are specific to the different range types, but does not identify where the specific problems are located. This section really could have benefited from an ecosystem-based structure.

2. The section on grazing is a litany of effects, mostly bad, that occur in a variety of degrees in rangelands of differing types. There are great differences between the impact of invasives, for example in the Mediterranean-type western foothills and the east-side great Basin types. Impacts in Riparian types, which is supposed to be the focus of this section, is mixed with examples from upland impacts. Discussion of issues about grazing must separate the different rangeland ecosystems. The section does not stick to its title, but this implies that there should be more grazing issues for non-aquatic/riparian/meadow types.

3. The comment on fair-value-fees is interesting, but why isn't this brought up as an issue in the other sections for other land uses?

4. Comments about adverse disease-based interactions of bighorn sheep and grazing should be confined to domestic sheep, not as a general problem with livestock grazing.

5. According to the issue statement "Grazing is directly related to extirpation of Least Bell's Vireo from the Sierra, declines in willow flycatchers, great gray owls, orange-crowned and Nashville warbler, golden trout, Lahontan cutthroat trout, bighorn sheep, several native amphibian and fish species." Is this sweeping statement proven, or is it a mixture of supposition, inference, and fact? How do the components of this statement apply to the Aquatic, riparian, and meadow systems identified as the subject of the issue. Some of these impacts, if true, do not occur in the system identified as the subject of this issue.

6. There should be discussion of how improved grazing management will work to rehabilitate these systems, what methods are tested and proven as represented in published literature, and how management effectiveness may be measured.

7. The issue statement greatly underestimates how the changes in grazing management and livestock numbers over the past few decades will affect the ability to properly assess grazing impacts.

8. The issue statement does not adequately refer to or build on the SNEP chapters discussing grazing. The major SNEP grazing chapter represents a fair start at organizing basic information, but is very difficult to sort through by the reader not thoroughly familiar with grazing ecology. Perhaps this is why the issue statement uses little of the information in the SNEP grazing chapter.

9. Despite claims (in issue statement and elsewhere in the SNEP report) that livestock grazing has been a primary disruptive force in Sierra Nevada ecosystems, this factor is not as well-developed as many other subjects in the SNEP report. The SNEP background and grazing chapters leave out important published primary information and are highly selective in content.
Therefore any management recommendations for livestock grazing have arelatively poor science base to start with. This is likely to pose a major problem for implementation of the Sierra Nevada Tasks.

10. The problem permeating the statements in the issue section about grazing is not just what new information is available, but what existing information was either not reviewed or improperly interpreted in the SNEP document. Curing this

problem will require much more analysis by unbiased experts if the material is to be effective in creating a set of viable grazing management alternatives for USFS.

11. There is little doubt that historic livestock grazing has adversely affected Sierra Nevada rangeland systems, but the list in the issue statement does not distinguish proven facts from hyperbole, and mixes impacts from a wide variety of different types of rangeland systems. Rangelands in the Sierra Nevada are diverse, and grazing impacts, management needs and priorities for attention likewise vary considerably among types and geographic regions.

For example, riparian systems have been srongly affected by grazing, but also may recover more quickly. Foothill rangelands have also been strongly affected by humans over the past several centuries, but, like other Mediterranean-type systems, hold much lower potential for restoration. The rangelands of the higher elevation western Sierra, the eastside, and the lower elevation Mediterranean Clmiate zone present very different management problems and should not be lumped.

12. Although I do not have access to it at this time, there is a primary source scientific literature available for the rangeland types in the Sierra Nevada that was not referenced either in SNEP or in the Science review draft.

13. Adequate development of ecological background and management alternatives for grazing in the Sierra Nevada will require some basic work, including upgrading of reviewed information, and much expansion and improvement of the issue statement. This job apparently will require more time and people than were applied to TASK 2, which did not come up with an effective grazing issue analysis.

14. I suggest that a small team of range scientists could help better identify the issues and available scientific information. This group could also be charged with developing a better information base. So far, the SNEP report and the TASK 2 issue statement have not been adequate to plan effective grazing management alternatives.

Reviewer 4of8:

To: Garland Mason

Date: July 20, 1998

RE: Review of July 10 manuscript: Sierra Nevada Science Review

Sections 5 and 6 arrived too late to be included in this review.

The "mixed approach" for the writing and organization of the report is not clear, and hence its implementation and use will suffer. The team describes the purpose of the report in various ways: to provide a review and synthesis of current scientific information (with attention to high priority issues)--including the incorporation of new information; to identify a new vision that will help maintain and enhance the sustainability of SN ecosystems; and to direct Sierra Nevada forest plan updates (and "help focus the PSW's efforts to conduct regional planning). Each of these objectives, in and of themselves, are complex and difficult tasks, and this report is unsuccessful trying to address them all. The organization of the report needs to be improved. Despite the call for integration, there is far too little of it, though some individual sections shine.

In Appendix I, the letter from Hal Salwasser suggests the body of the report be limited to 30 pages. The sections I received, however, total two to three times that length. The document will require considerable shortening and focusing on priority items if it is to be helpful to forest planners and others.

The list of priority issues is useful--and can be valuable—although the sections are not uniform in quality or, on the whole, balanced in relationship to each other nor integrated. The treatment of the issues in the section "Demographic and Socioeconomic Changes" is not balanced in length, focus, or emphasis with the sections on non-human issues. At the beginning of the document, the report states that integration of environmental and social issues is a basic management philosophy, but the statement two pages later that new socioeconomic knowledge is difficult to assess sounds like an apology for incomplete coverage. The space devoted to socioeconomic issues is equal to that of a single

species discussion, and the socioeconomic changes section generally lacks clarity and directness. This limited treatment is inappropriate if interest in integration of environmental and social issues is sincere. The adaptive management section contains a useful social and institutional emphasis but lacks concrete suggestions needed for successful implementation of issues about which there is considerable inexperience and misunderstanding. As is, the document emphasizes non-human elements. This focus should be made clear, or more work is needed on socioeconomic and other human/institutional elements.

The team assumption, that "all national forest management approaches use--or strives diligently to improve--ecosystem management approaches as a standard operating approach" and that "management philosophy continues to focus MORE ON ecological process, interdisciplinarity, ecoregional boundaries, multiple jurisdictional coordination, adaptive management and monitoring, and integration of environmental and social issues" is incorrect. First of all, the language is unclear; "management philosophy continues to focus more on ecological process........than on WHAT? Second, and more important, this report is necessary because the team's assumption is erroneous. While many of the aforementioned may be part of a management philosophy, few national forests have effective adaptive management programs in place, even fewer have necessary resources devoted to monitoring and, few, if any, effectively integrate environment and social issues.

While the team is explicit about not recommending management approaches or actions, more attention devoted to the relationship between science, management, and the implementation of new information would aid the team's report. The team's charge to recommend a new vision suggests that new management approaches can result from the document. Is the purpose of this report to provide information for others to determine or discover appropriate management? If so, can this report be more specific and even prescriptive? While specific direction is difficult given rangewide variability and potential NEPA conflict, more direction and examples are needed. Examples might identify how to implement and accomplish some of what will prove to be difficult. Examples could beset off in boxes in the text.

The statements and questions in the section "Relationship with National Forest Management" in Old Forest Ecosystems; Forest Carnivores and Old Forest Ecosystems: Spotted Owl are two excellent examples of concreteness and the use of questions to effectively improve management. Other sections would benefit from similar attention to the application of scientific findings. The integration of similar examples throughout the document would make it more effective and useful..

The sections on Old-Forest Ecosystems (general approaches to studying old-forest ecosystems) and FEMAT and SNEP: A Comparison..., are superfluous, and, while raising interesting issues, do not fit with the existing document. They need to be better and more thematically integrated or left out of the document. Rather than providing a comparison of the two, the FEMAT and SNEP comparison should be contained within a discussion of FEMAT approaches relevant to the Sierra.

A number of items under "Synopsis in The Demographic and Socioeconomic Changes" section are poorly written. Some of these items are not new information and are unlikely to provide direction for managers working for a sustainable region. Some examples: "Demography and socioeconomics continue to revolve" is not new information. Have demography and socioeconomics ever not continued to evolve? Additionally, this issue ignores variation within regions. While there are communities throughout the Sierra primarily dependent on raw material extraction, no region in the Sierra is "primarily" dependent.

The statement that Native American tribes' interaction with county and state governments over land acquisition fosters controversy is nothing new, and it is unclear how interaction will help maintain or enhance SN sustainability or improve national forest planning.

Two priority issues, beginning with "Public and agency demands" and "Settlement patterns" lack the necessary clarity and direction to be useful.

The issue beginning with "Land managers are being asked to anticipate" is useful as ahighlight of some topics that need to be considered when management plans are developed.

There should be consistency with the use of citations for individual priority issues. Many of the priority issues have citations, but some, such as Demographic and Socioeconomic Changes, and Oak Woodland Ecosystems, lack citations except at the end where they are listed as "additional citations.

Reviewer 5of8:

To whom it may concern:

I have reviewed the draft "Sierra Nevada Science Review" documents in light of the "Charge to the Science Team" given in Appendix 1. Overall, the review is both competent and complete. My specific comments below are identified by section and quotations rather than page numbers, since the page numbers on my hard copy are a function of the font and printer I used to print it out with.

1) Introduction/General Approach: "...the team felt the best solution was to take a mixed approach."
The "mixed" approach to organizing the review did not detract significantly from its implicit ecosystem management framework.

2) Introduction/Choice of Species: "Although the team supports a change of approach from piecemeal management to systems and process monitoring, individual species crises do not go away..." More to the point, preexisting administrative procedures and judicial interpretations associated with the Endangered Species Act do not go away.

3) Introduction/Section Organization/Relationship with National ForestManagement It might have been useful to extend the scope of these sections to incorporate relationship with the Forest Survey, at least as regards monitoring issues.

4) Priority Issues/Fire and Fuels/Synopsis: "The number of fire-fighting resources has been steadily declining..." This statement should be qualified. There has been a modest decline in engines, but air resources have been relatively stable, and local resources (not dealt with in Husari and McKelvey) have probably been increasing, at least at lower elevations.

5) Priority Issues/Fire and Fuels/Relationship with NF: "Development of broad-scale or landscape-scale strategies for fire management will likely be more effective..." This seems to presume that the priority objectives for fire management are related to wildlands rather than inferface areas.

6) Priority Issues/Fire and Fuels/Old-Forest Ecosystems (1): Original Sierran old-forests APPEAR to exist as inteconnected..." Important issue of tense indicated by capitalization.

7) Priority Issues/Fire and Fuels/Old-Forest Ecosystems (1): "Remaining old-forest patches are rare, valuable, and subject to loss by wildfire." Is the intent to highlight their differential susceptibility to loss by wildfire or the ecological consequences of such losses?

8) Priority Issues/Fire and Fuels/Old-Forest Ecosystems (1)/Relationship with NF: The importance of the relationship between the NF and USPS might be noted here.

9) Priority Issues/Fire and Fuels/Old-Forest Ecosystems (2)/Relationship with NF: The relationship between NF habitat and adjacent private ownerships might be noted here.

10) Priority Issues/Aquatic, Riparian.../(1)/Primary Scales: "River basins, with emphasis on planning watersheds" Does this presume a similar scale for related endangered species concerns for salmon?

11) Priority Issues/Oak Woodlands/Relationship with NF/Fire and Fuels: The issue of interagency cooperation on prescribed burning in interface areas might be noted here.

12) Priority Issues/Monitoring: The issue of collaboration with other agencies with a monitoring mandate, or with NGO's with an interest in or capacity for monitoring should be addressed here.

13) Old-Forest Ecosystems/General Approaches: "Section incomplete..." This section identifies some important inconsistencies in the approaches to old-forest issues, but does not yet meet the charge to the committee in terms of addressing the implications of the new scientific findings.

Reviewer 6of8:

July 20, 1998

In the section: BACKGROUND, there is some clarification that is needed. The following paragraph includes that clarification.

In late 1996, the Secretary of Agriculture chartered a California Spotted Owl Federal Advisory Committee (FAC) to evaluate whether the Forest Service RDEIS adequately integrated all current and ~~available~~ NEW significant information, specifically that compiled in the SNEP reports, relevant to the management of National Forest System lands in the Sierra Nevada. The FAC report, published in December 1997, concluded that the RDEIS was inadequate in its current form as either an owl or an ecosystem management Environmental Impact Statement. PART OF THE REASON FOR THIS IS THAT THE COMMITTEES CHARGE WAS TO EXAMINE NEW INFORMATION THAT THE USFS TEAM DID NOT HAVE ACCESS TO AT THAT TIME. NONETHELESS, the RDEIS, thus, was not distributed and an alternative process for addressing management of Sierra Nevada national forests was begun in early 1998. This has become known as the Sierra Nevada Tasks, and the collective goal of the tasks is to incorporate new information that will help to maintain and enhance the sustainability of Sierra Nevada ecosystems. Four discrete but interlinked tasks have been identified as follows....

In the section: DEMOGRAPHIC AND SOCIOECONOMIC CHANGES I fail to see recognition of major impacts due to change in cutting levels that have recently occurred on NF's. These would include an economic analysis of the effects of lowered annual cutting levels, the impact on communities, the impact on families involved with these industries. This is a significant and major change that has occurred in a very short time, yet there is nearly no mention of it, and no analysis or recommended analysis.

In the section: FIRE AND FUELS, you did a good job of picking the critical items for analysis, with the exception of smoke management. This is going to be a major social acceptance problem and we as a profession are essentially unequipped to deal with it. This issue should include research on smoke effects of varying intensities/durations on the aged and infants as well as the general population. It should address the effects of smoke on businesses and affected communities from an economic standpoint. And lastly, it should address the political ramifications of public outcry on the overall fuels reduction plans, and subsequent negative affects on the attributes of the burn plan.

In the section OLD-FOREST ECOSYSTEMS: (1) FOREST CONDITIONS OF STRUCTURALLY COMPLEX FOREST TYPES, and in the section OLD-FOREST ECOSYSTEMS: (2) CALIFORNIA SPOTTED OWL (*Strix occidentalis*), I read the best interpretation yet of the various studies. Good job.

However, monitoring of other species, NOT CURRENTLY OF CONCERN needs to occur. I support the many changes being proposed to protect the California Spotted Owl, but stepping back to look at the entire ecosystem and the long term

dynamics of these systems, it's relatively easy to imagine that reverting our landscape and its composition back to some condition that existed 50 to 100 years prior, may indeed create a condition that threatens the sustainability of other species. The only way to really know is through a well developed monitoring program that looks at all species in the system and tracks their viability. It's easy to focus on the "hype" that surrounds one threatened species, and rightfully it should not be ignored, but we can't manage the world species-by-species in a crisis management mode. It's not affordable, and it's not reponsible.

Once the definition of a "heathly" ecosystem has been defined, scientists (as well as the public) must understand that it is not going to protect every species and combination of species that are possible or even probable. Over time, some will come and others will go, and this may be based on factors that we can't control (climate, catestrophic events, etc). People have to realize we can not, at any cost, save everything.

While monitoring is expensive, monitoring has to be in place for a multitude of other reasons; it just needs to carefully thought out for the long-term, not just for the conditions that exist today.

In the section OAK WOODLAND ECOSYSTEMS, some interesting points were made. However, as it now reads, it sounds like ag conversion is not much of a problem and that through education problems have abated. While there has been some improvement in a few localities, the majority of the ag-related loss of woodland problems still exist. Also, from personal conversations with ranchers, there is a surprising attitude that now that the "heat" is off since CDF and others are currently looking at loss due to urbanization related issues, it's back to business as normal. In short, the problems have not disappeared.

This is especially alarming given that urbanization and fracturing of the oak woodland landscape has also increased, and that oak woodlands are third only to wetlands and riparian areas for diversity of species (e.g., with over 110 species of birds that use the woodlands). These points were not brought out in the report.

Reviewer 7of8: (Part I)

A review of
Sierra Nevada Science Review
A report of the Science Team

In a second memo to reviewers, Assistant Director Mason stated that full editing of the Report was incomplete. I will only indicate places where language or logic is missing rather than obvious incorrect punctuation and other editing points (which are numerous). It was my understanding that this report was to be short, about 30 pages. The time limit for reviewing this lengthy (ca 80 page) product was insufficient if the Forest Service sincerely wanted careful review.

The PSW science team might try constructing some tables that compare such sections as scale, geographic region, species, etc. for the various issues. There is overlap among the Issues (as there should be) but the magnitude of the Report makes it difficult to follow all the connections.

Introduction
Paragraph 1 describes a chronology of the CalOwl EIS and states that the RDEIS was prepared for public distribution in spring 1996. If this is so, then actual start of release in August 1996 (in order supposedly to fully consider the findings of SNEP) is in conflict with this statement. Paragraph 2 (clear up typos and broken sentences in the middle)
The text states in the last sentence that SNEP conducted no comprehensive alternative management plans. One might argue that Chapter 6 in the Addendum by Johnson et al. (1997) is a fairly comprehensive management plan that considered a wide range of options (similar to national forest planning) which were evaluated in the terms of watershed effects, timber outputs and values, fire and fuels management, old growth expansion and other attributes. Although limited to two national forests, this chapter certainly integrated many of the sections and topics addressed in SNEP assessments. Some rewording of the end of this paragraph could clarify the meaning.

Para. 3. summarizes the charge to the FAC. By jumping from spring 1996 (paragraph 1) to late 1996, the Report leaves out why the FAC was formed and why the RDEIS was not released as planned. Further, the summarization of the charge to the FAC implies that this summary was the full charge which it was not. Indicate perhaps that one of the primary objectives was as the Report has stated or else give the charge to the FAC. The FAC report was released; I'm not sure published is the best word here. Notice also that the conclusions of why the RDEIS (p. 5) was inadequate are not consistent with the limited charge the Report gave at the beginning of this section. Near the end of this paragraph on p. 5, there is a truncate diversion of the "Sierra Nevada Tasks" which states that the goal is "to incorporate new information." Reading of Task 4 shows why this definition is incomplete. Task 1. There is internal conflict with the description of this task as being "improving consistency of the management" and then later as "to improve conservation options." There is considerable debate, apparently, about what this letter meant as reflected even here. Task 4. I have heard that the new, amended name of this task is now "The Sierra Nevada Conservation and Collaboration Framework" or has it changed again? Is it true that the interagency executive group directs staff "to ...conduct projects of common interest in the Sierra?" All Tasks. These four items are not parallel in structure and could be improved grammatically if they were. p. 6, Approach, paragraph 2. This assumption is enormous and incorrect. The conclusion of the FAC found in part that even the planning for ecosystem management was flawed. What is the need for this assumption? There is a need to state that in order to carry out most of the actions stemming from this science review it would necessitate that national forests use ecosystem management across the range and collaborate in a new structure
for multiple jurisdictions. The simple fact is that each forest operates independently and there is little or no Sierra wide system approach, either within the Forest Service or among the Forest Service and other government entities.

p. 8. I am unsure of what is meant by the statement in the top paragraph that says the Forest Service efforts address species at risk programmatically (AND at the project level)? I hesitate on the word "programmatically." For example, refer to the section for Future Clarification, Other Widlife Habitat: Carnivores where it states "ForestService PSW Region is currently soliciting information on the specific criteria that each Forest used to establish their marten and fisher mangement areas and to encourage those Forests that have no specific areas designated to do so[emphasis mine]. Hardly a programmatic approach. Section Organization
Organization in the text follows a) Issue, b) synopsis. Key Species at Risk does not seem to be a heading or an organizing feature; they are sprinkled here and there under all headings. Include the wording about species, perhaps, under synopsis and other headings. There seem to be some items of special treatment attached to Relationship with National Forest Management that should be explained (those in capitals after RE:).

p. 11. This page is redundant, I think. You've already explained Priority Issues.

Issue: Demography and...
Synopsis in general. These sections are very uneven and completely unparallel as one reads from one * to another and from one Issue to another. As a result, the reader must readjust thinking (and translating) almost line by line. On p. 12, the second item lacks sentence structure. The fifth item says "...assessments by science and ...metascience are clarifying..." for example.

p. 13. Relationships with National Forest Management. The relationship of coordinated and collaborative planning is more than a need "to be evaluated for a better understanding..." To carry out ecosystem management of many of the issues will require the FS to implement cross jurisdictional planning and projects. Evaluation (or adaptive management) will also be necessary, of course, but the bigger relationship will be the ACTION.

Issue: Fire and Fuels
The second item in the synopsis fails to clarify the separate roles of temperature and moisture. If increased temperature causes an increase in fire frequency, would that not be another way to say that there is a greater concentration of fires during some period, i.e., greater synchronization? Can fire-ring analyses differentiate within season (year) synchrony as we understand the phenomenon of events in 1987, for example. What is the time scale for synchrony caused by moisture as opposed to increased frequency caused by temperature? Both variables account for variation in fire/scar-ring history. What amount of variation and which is more important? The research summary from recent work is interesting but the point is lost. What is the point? That large, stand replacing fires have been more common than supposed or that they are a post 1850 change? Therefore, is there some overemphasis on the dogma of "small, cool, non-stand-replacing wildfires?"

p. 15, third item. Perhaps this could be said more directly as "a large amount of carbon was stored for centuries as charcoal in soils and deep sediments (meaning lake or ocean?)." Fourth item. The point about a change in fire intensity refers back to SNEP papers apparently. No new evidence seems presented, and yet, the SNEP fire summary made a point, as did McKelvey, that there are no data on historical trends in severity. The summary in the Report here gives a conclusion based on inference from inference and fails to mention there is a lack of data.

Last item on p. 15. The list of factors contributing to fuel build up seems to include everying except logging. Can it truly be that mining from the 1800s still has an effect on the abundance of fuels but logging from 1850 to the present does not?

p. 16. If increased growth of young trees is likely a result of warmer, moister conditions, could it also be that the same phenomenon occurred in the past; that is, the fuels cycle is more a function of ingrowth under the warm/moist than a function of fire suppression?

Item 4. The sentence "Intermixed urban development...poses increased threats to life and property..." needs a little rewording. It may be true, but maybe not in the way stated.

p. 17, Basis for Inclusion.
The first item differentiates upland and riparian with a conclusion not supported anywhere in the synopsis. This aspect comes up in more detail later (under Riparian/Aquatic), yet it seems that if there is new evidence for understanding the role of fire in riparian systems, it needs inclusion here or else drop this sentence from the Basis for Inclusion or simply state "most vegetation types...". The rest of the first sentence perhaps overstates the case a bit. Suppression and/or climate may have changed some of the frequency and severity of fire. Is it fair to say that fire has "been removed as an evolutionary force?" That implies fire no longer occurs. The flip side of this coin, which comes up later of course, is what to do about "restoring fire." If we impose some new, human-directed fire regime, is it your understanding that this process will restore the natural evolutionary force (regime)?

Geographic Region of Concern
The listing of veg. typesseems like an unnecessary. It might be simpler to state that all Sierra types are fire-adapted and are included.

Item 3. Once again, a meaning (geographic region) becomes converted into a sudden insertion of an aspect of all types—riparian corridors. The linkages or isolation of different elements within types (e.g., upland vs. riparian, mesic vs. dry, etc., east slope vs. west slope) should be explicit in the synopsis if it comes up here. Two areas, "Human health..." and "ecosystem sustainability.." also seem more appropriate under Basis for Inclusion and are connected to two of the items already under that heading. I don't quite follow the meaning of "areas of ecosystem sustainability and resilience" and the clause that follows does not help. Do you mean "areas of currently threatened ecosystem sustainability and resilience?"

p. 18. Primary Scales for Consideration.
The recommendations from SNEP were "...a landscape level strategy...need(s) to begin in the most logical, efficient, and cost-effective places." The advice in this section of the Report seems unconnected to any of these three points. What is the basis in other studies that has moved this science team to conclude that "spotted owl and forest carnivore habitat areas and old forest and riparian ecosystems.... and areas identified locally (emphasis mine) as high priority ecosystem values" have primacy for fire and fuels management? Be careful: this conclusion seems to reflect the personal choices of the science review team rather than one that has grown out of either the SNEP documents or new studies mentioned in the Synopsis. It may be that the evidence is there, but the synopsis has not led a reader to understand this important point. Once again, riparian is inserted without any basis for its inclusion as a primary scale of consideration. What is mentioned in SNEP, suggests that riparian conditions are sensitive to management that would change the inherent conditons (low temperature, high moisture, high growth, etc.) that make them important habitats. With respect to DFPZs, SNEP (Weatherspoon and Skinner, p. 1481, Vol II) said "Because of their relatively moist environment, untreated or minimally treated riparian zones normally should not present an undue risk of serving as a "fuse" to spread fire across a DFPZ..." There may be reason (ecological and cost-effectiveness) to include riparian systems when prescribed fire (and other managed fire) is applied in a general area (selected for priority reasons), for all the reasons explained in the synopsis. But no case has been given for selectively seeking riparian areas for burning or thinning. In addition, a team of aquatic ecologists in a SNEP sponsored

workshop did not support managing riparian areas for fuel reduction (See Kondolf et al. chap. 36 and N.A. Erman Chap. 35,Vol. II.) I suggest deleting the term "fire-sink effect"—explain in more direct language.

The second item concludes that effective management of fire requires broad scale strategies. Following the previous item, which concluded with fire-fighting capacity, the second item might be confused as a continued discussion about fire fighting managment strategies.

The section on Scales is somewhat at odds with the next section on Relationships. The full impact of some of the fuel strategies developed by SNEP and others is lost here. Much attention in SNEP chapters (including the application chapters 1-6 in the Addendum) was paid to the need for something more than "Local priorities are determined by..." Implementation of DFPZs or widespread prescribed/managed natural fire will not be realized by strategies that fall back to "local priorities". One example in SNEP (Vol. II, Chap. 56, p. 1481) even pointed out that the routine process of treating fuels, currently practiced after logging, in not additive across the landscape and effectively has no influence on reducing fire intensity much beyond the treated area.

Relationships with National Forest Management
Many of the same points made above could be repeated in this section except the section emphasizes broad-scale strategies. The section gives a list of "resources concerns" but omits any priority setting process. And most importantly, it has ignored entirely the necessity of "...cooperation among landowners, local entities, and fire agencies..." (SNEP Vol I, p. 1037) not only to protect human life and property in the lower elevation zones but also to manage fire and fuels throughout the entire range.

Issue: Old Forest Ecosystems 1. Forest Conditions of structurally complex forest types.

Synopsis. (Check verb tense; I suggest past rather than present.)
Item 3. I suggest the Report always define by additional terms the meaning of diversity. The meaning here I presume is Structural Diversity?

p. 2. I suggest moving the third item (4%, 18 species...) in front of the second item on this page. The fourth item ("authors ues different definitions..") is more aptly explained by the first sentence than the second. The differences are not due solely to whether the vegetation is viewed as wildlife habitat, vegetation communities or scales. The arguments dating to perspectives in community continuum vs. individualistic stands is as much at the root as the differences between a plant community view versus a habitat view. It is difficult to summarize (or characterize) the full nature of these differences in a synopsis, so perhaps less is more here.

Item 5 (Recent landscape-level..) The context here is understanding historical conditions and fire. Thus the sentence "Upper slope positions..." needs to add that "In response to more frequent and severe fire, upper slope positions..."

p. 3. Item 1. This truncated version is hard to follow. Break it into bite size sentences that first go through the methods of assessment: 1) specialists, 2) polygons—give range of sizes here not later, 3) number of forest types, 4) ranks, etc. Add the point in Franklin and Fites-Kaufmann that LS/OG is not a 0/1 classification and therefore ranks are based on relative amount of HIGH QUALITY LS/OG.

Item 2. This synopsis does not clarify or help explain the meaning from the Langley study or the modelling of Sessions et al. as validation of the LSOG classification. A full review of these and other studies on each technique is admittedly hard to include in the space. But understanding how each produces a rank or classification is critical. As noted in the earlier item on p. 2, results of classifications are a function of the objectives and methods used to get the data. These two other studies can not be ignored but the review leaves the impression that the LSOG classification by Franklin and Fites-Kaufmann is incorrect or flawed. Both Langley and Sessions et al. approaches must by definition result in some different ranks because they come from a small plot-based method of building up ranks for a landscape. The mappers identified "patches", described in SNEP as on the order of 500 acres! Somewhere in that patch, either a 0.4-0.8 acre plot (surveyed by SNEP-hired field crews) or FIA plots of 2.5-5 acres were located. Both methods then are compared to these much larger areas; whereas, mappers were asked to integrate the average of a series of these patches over a polygon of up to several thousand acres. There is too much to go into in this synopsis (e.g., such fine points as there were only 6 plots by Langley in Rank 5 on

which to base conclusions) yet this Report sums the agreement for 4s and 5s. If there is a conclusion from the two "validations" it would be that the mappers were more generous in assigning ranks 4 (and maybe 5) than were the other two analyses; in other words, there is even less LSOG than the mappers concluded. Using the conventional small-plot based methods to compare with polygon-based classifications is cause for caution. The PSW science team could provide help here, not so much by breifly reviewing parts of the methods and results, but in interpreting the implications, limits and meaning the studies have for the broader understanding of LSOG. The Sierra Biodiversity Institute "method", by the way, could not be reproduced by others since it hinges on personal "ground truthing" of the TM data. And, this section, I believe, comes from the chapter by Davis who is not cited.

Item 4. The review of Beardsley et al. does not have any point, except to say that there is another method of classifying LSOG according to a structure and sample/plot design of the FIA. Even with 1,907 FIA plots each plot is spaced over approximately 4,450 acres. The SNEP polygons were 500-2500 acres. It looks as if there might be room for some disagreement when plots or patches get expanded either by computer ™ or human minds (mappers). The reference to the degree to which the remotely sensed maps agreed with field checks of life form and CALVEG types (summarized in the section on Further Clarification) is not exactly a quality check on the accuracy of LSOG patch classification.
There is no explanation of the meaning in this item for the 4% in "reserved lands" and the Report should use the full name for the national park called "Lassen."

Item 5. Explain/modify "diversity." Has the team reviewed and rejected the published notion that extensive livestock grazing and resultant burning may have been another factor in the change of forest structure?

p. 4, Item 3. Without specific policy to exempt LSOG (other than owl sites) aren't the remaining patches or polygons also subject to loss by logging, roads, mining, (insect outbreak, wind,....)? Fire is a somewhat random event that to date for whatever reasons has spared these vulnerable patches. Human activity, by contrast, is quite deliberate and strongly backed by many social forces including "get rid of it before it's a problem", "let's burn/log it to save it", "let's road it before we can't" and many other rumored and publicly stated motivations.

Item 5. The usual view of competition has been that large (dominant) trees stunt and retard growth of those below it. Are you saying that this view is no longer accepted, i.e., that it is the undergrowth that is weakening the overgrowth?

Item 6. Who did the "evaluation of 10 different proposed...", the PSW science team? And what are the "critical old-forest design criteria?" Is this reference to the paper by Franklin et al. 1997? References to Franklin and Fites-Kaufmann 1996 are confusing here since they only refer to ALSEs briefly (p. 653) and then cite Franklin et al. for the full strategy.

Item 7. Is the simulation modeling analysis the paper by Johnson et al. 1997? If so, cite it after the first sentence. Again, the ALSE strategy is more properly Franklin et al. than Franklin and Fites-Kaufmann 1996).

Geographic Region of Concern and Primary Scales for Consideration (p. 5)
The list of forest types here excludes Foothills Pine and Oak, Pinyon & Juniper, and Riparian Hardwood as listed in SNEP (Franklin and Fites-Kaufmann). It is unclear if the Report considers riparian elements as distinct "types", takes issue with Riparian Hardwood as a type, or believes that riparian elements within a type need mention so that readers don't forget there are streams in all forest types. In the section on Basis for Inclusion, foothill and riparian types are mentioned. Was this an oversight in the earlier section or has the PSW science team made some determination in this review that was not included in the synopsis?

Basis for Inclusion
It is unclear how the repetition of the change in fire regimes is a basis for inclusion of old-forests. This repetition seems more intended to reinforce conclusions about another Issue-fire and fuels. Literature previously cited is redundantly cited again.. If the linkage between fire and old forests must be made again, this statement offers little to help understand why it should be under this section.

p. 6. What is this list in all capitals after RE? There is no explanation and the connection to the outline of contents is absent. The formatting makes this seem special but why it is special is unclear.

Reviewer 7of8: (Part (II)

Issue: Old-Forest Ecosystems, (2) California Spotted Owl
Synopsis
This section reads like no other before it. It takes on a much more tutorial slant that tells a story while reviewing the literature. It seems to have good, new information that the team apparently feels cannot be paraphrased and must be quoted directly, as opposed to almost everything written in previous Issues. The problem with directly quoting is that one is left to conclude that the statement reflects the sum of the judgement on relevant data by the PSW team. Has no other work on suitable habitat for spotted owls been done before Bart? It would help readers less familiar with the controversy and literature on this owl if the team could bring together what has guided policy to the present and amend it or support it with the new evidence. So, perhaps start with something like items 2, 3, 4 and then summarize the implications of Bart. Otherwise, starting with Bart and concluding as the first paragraph does, one is left to conclude that the only basis for managing habitat for the California owl is the data for Northern spotted owl. Please use language to explain lambda.

p. 8, item 1. The results here are interesting but their relevance to the overall goal of this Report is unclear. Does the irregular nesting fact change understanding of owl management or CASPO guidelines?

Item 2. The association of age and size is not entirely clarified by this presentation. It seems that big trees are indeed old. But the implication in the first line could be that there is a significant regression between size and age; and that point has not been clarified. Explain what the relationship was between age of trees and size of trees.Be more direct in what these data help clarify.

Item 3. The reference to new information cites McKelvey et al. 1996
(reference list not included in Report) Is this a SNEP reference? If so, the SNEP chapter by McKelvey states that there are no data on fire
intensity.

Basis for Inclusion
There might be some reference to the continuing need to finish the aborted RDEIS for management of the CA spotted owl rather than citing other subspecies that have been listed. Are these other subspecies relevant to the issue of the CA spotted owl in the Sierra?

Relationship with National Forest Management

Item 7 brings up an important finding that appears as a question here. The integration of SNEP (if this is the basis of the old forest maps) with owl work is new and interesting and should be brought out in the Synopsis. It might require explanation of "poor fit" as well as whether the fit is to "habitat" in the abstract or more specifically to actual locations of birds.

Item 8 also seems to bring up an important scientific finding that should be summarized in the synopsis.
Last item. Asking this question implies there is speculation (or preliminary data?) that is relevant to management. One might assume there is also the potential of negative impacts if the interim guidelines were lifted (as some in Congress have proposed). There should be some basis in the scientific review for dealing with this possibility in the Report. I am not sure that a simple question responds to the objective to consider
implications of the interim CASPO guidelines as stated in the introduction of the Report. Given the special section later, this question seems of little value here.

Issue: Old-Forest, (3) forest carnivores
Synopsis
There is reference here to roads as a possible factor in the declines or failure fisher populations. The SNEP report (Vol. I, Chapter 36 for regions, a Moyle chapter Vol. II for watersheds) provides summaries of road density that showed that the

northern region has far LESS road density than central, southern or eastside regions. It wuld be possible to analyzie the correlation among actual watersheds, GIS identified fisher habitat and roads.

Paragraph 2, p. 10. Clear up the use/spelling of marten, martens, marten's.
The balance of this section for the other species does not seem to offer new information and duplicates comments in SNEP.

Relationship with National Forest Management
The structure of the list that follows is incomplete sentences and differs in content from the items listed in previous Issues. Try for some consistency.

Issue: Aquatic, riparian and meadow ecosystems: 1) low-to mid-elevation.
Synopsis
Not all meadows are aquatic dependent or wet. Their origins and existence as units are more diverse and the Issue should either clarify that or treat it somewhere else as well.

Item 6. A major point of the chapter by Erman in SNEP vol. II was that much of this invertebrate diversity was associated with small, headwater, and temporary habitats. This association is critical for later discussion and understanding of differences between FEMAT, reserve-based strategies and the SNEP riparian strategy. The numbers of invertebrate species are also a significant contrast when management strategies are developed based primarily on fish or other vertebrates. This chapter and
Vol. II, 36 also point to the relatively greater sensitivity of smaller than larger aquatic habitats to disturbance from adjacent land uses—a factor that is inverse to current management/protection policies (andFEMAT).

p. 16, item 4. This statement requires more explanation. The reference to Skinner and Chang in SNEP is not on this subject and it is unclear where the basis comes from to state "Current characterization of riparian corridors that treat them as uninfluenced by fire..." What science assessment has made that characterization? Certainly, nothing in SNEP claimed this. What are the recent data that suggest frequent fires in riparian areas? It is important to give the evidence that is new or relevant, not only to conclude.

Basis for Inclusion
SNEP (vol. I) also concluded that these ecosystems were the most degraded (a point cited elsewhere in the Report).
Geographic Region of Concern
The list here is of some aquatic habitats. Would it not be better to say "Aquatic habitats and associated communities Sierrawide?"

Primary Scales

p. 20, item 1. The sentence is incomplete with a dangling "and California Department of Fish and Game."
Relationship with National Forest Management Certainly management of riparian systems is connected to management on the national forests and is critical to this issue. This list could also include many other activities in which NF management affects these systems (as summarized in SNEP, Vol II, chap 36), including grazing, water projects (requiring FS permits), mining, recreation (e.g., location of campgrounds and septic systems). There is no mention of the major sections in SNEP Vol. I, Vol. II (chap 36), Vol. II (chap 5) and Addendum (several chapters) that deal with the importance of buffer systems (stream and lake management zones) and their connection to aquatic, riparian and associate community protection. It has major implications for national forest management in the Sierra (and is reflected in the Issue on forest carnivores as well) yet is not mentioned here. There is no mention of one of the conclusions from Chap 6, Addendum (Johnson et al.) which noted that avoiding thresholds of cumulative watershed effects will increasingly mean that there will be no allowable activities (or very little) on public lands if isolated management by public and private land ownership continues. SNEP also considered the linkage of riparian corridors with ALSEs as a potential future management direction that would provide benefits to both.
The point of listing RE: Fire and Fuels is unclear. This is a repetition of the statement given in a synopsis and connection here is undeveloped.

Issue: Aquatic, (2) High elevation

Synopsis
Item 6. Change to "...biota that existed historically in fishless aquatic systems." Change to "Cumulative effects from widespread stocking and associated management..."

Item 7. The point of these sentences ("Both kinds of lakes can be identified...") is not quite complete and needs rewording. The significance of identifying both kinds of lakes should be stated. One presumes it is to identify lakes where stocking should be eliminaed.

p. 19, Item 3. The statement ("Current characterizations of riparian...") is identical to the statement in the Low-Mid Elevation section on Aquatic/Riparian and my earlier points apply.

Basis for Inclusion
This section seems to rely heavily on species listings as a basis for inclusion. There seems little basis to use Lahontan cutthroat or golden trout as "umbrella species." This fact in no way diminishes cause for concern for these species. The synopsis draws heavily on the aquatic connections for amphibian declines but I wonder if some consideration should be paid to the terrestrial stage of these species, especially because of declines outside of dense lake basin areas elsewhere in the range. Inclusion of land management could also broaden the scope of this section on Basis for Inclusion.

Relationship with National Forest Management
Many of my comments given in the previous section on low elevation aquatic/riparian can be repeated here.
Issue: Aquatic (3) Grazing
Synopsis
At the end of the first paragraph, use the term pathogens instead of "bacterial" because some of the organisms are not bacteria.

Geographic Region of Concern
Mention of "bighorn sheep disease transmission" (reword to transmission of diseases of domestic sheep to bighorn sheep?) comes up here without reference in the synopsis. The topic is covered in detail later, so at least link by cross reference. The "RE" list for terrestrial biodiversity mentions buffers but I am unclear if the sense is the same as used elsewhere (in connection with riparian). The connection between funding and invasion of plants is not explicit. Is the problem that the FS has no funds to work on plant invasions? To say "fair payment for use" is an undefined concept. It might be better to say that payments currently are below costs or payments should be increased to reflect management needs, etc.

p. 6., next to last line. Is clear cutting the only cause for concern in altering hydrologic functions in montane meadows?

Issue: Aquatic (6) Bighorn sheep
Synopsis
Item 3. Reword from "as heavy winters" to "such as winters with heavy snow"

Relationship with NF Management

p. 8. item 2. Is it domestic livestock or just sheep?
Issue. Oak woodland ecosystems

p. 11, under Relationship with NFmgt. It would seem that here, especially, the coordination and collaboration with BLM and state agencies is crucial and should be highlighted.

Issue. Roads

Item 1. Use other language for "take a hard look at"

Item 2. It is unclear and odd that language here states there is a need for "Developing a premise for new road construction..." It seems out of place and disconnected to the rest of the logic. What is the intent of this sentence?

Item 3. It would be hard for most people to believe that there has not been a roads policy in the Forest Service. There is much in FS budget and many other elements of operation that in sum constitute a "build roads policy." The last sentence in this section is a bit of a platitude. Reword?

p. 13. It is unclear in the top, continued section what "subsistence" means or what "habitat niches" means.
This section could also refer to data that was developed by SNEP (Chap 36) that summarized road density by region in the Sierra and by road/stream interaction (called Road Impact Index). The current section is fairly general and has an apologetic tone rather than a science summary/review/synthesis of the issue of roads.

Basis for Inclusion
This statement is weak and lacks many of the points brought up elsewhere in the Report (e.g., problem of roads for forest carnivores, riparian fragmentation, etc.).

p. 17. The list at the end under Relationship with NF mgt is too abreviated to know what is implied or intended. The PSW science team may have been running out of steam here (I am!) but just to say, for example, "Budget (long-term dedication)" is not revealing.

Issue: Effects of CASPO
I thought I read elsewhere in the Report a summary of recent owl survey work that has found continuing declines in the populations and breeding success. Is this relevant here?

Relationship with NFmgt
The same point under GRAZING about the meaning of "fair payment" needs to be explained.

Issues for Further Clarification
OLD-FOREST ECOSYSTEMS
Well, I do like the first sentence. The PSW science team has also found that there is apparently much dead wood, senescence and decay in colleges and universities. The items reviewed here seem based on studies, yet none (besides Davis and Stoms 1996 and Walker 1992) are cited. Perhaps the science team wishes not to point fingers. But by leaving out citations, it makes the items more like a lecture. Some of the material was mentioned earlier (under old growth). In some ways they go no further than the general language already given in the first paragraph.

Current approaches to defining....
The existing paragraph repeats many of the same points given once or twice above. Move the section about Bolsinger and Waddell up to the section above and perhaps omit the rest. If the comparisons can be reduced to a table (criteria as given already) with checks in the boxes by each of the examples, do it. Parts of the text that follows is already truncated and almost in outline form.

SNEP: Structural Complexity
Primary Criteria
If this section remains, it might be amended so that not only the various categories (e.g., cover of overstory, decadence, etc.) but also the scales (as you gave for large-diameter trees= over 40" dbh) used to define late seral condition are included. p. 7
Move the area of polygons up to the first reference to polygons

Geographic scale.
This section is mostly methods ("specialists mapped polygons...")

Management Extensions.

It is unclear which authors (or SNEP chapters?) or studies are being referred to in the three subsections. p. 8 Sierra Biodiversity Insitute Much of this section is redundant with the earlier Issue on Old Forest. Can these sections be combined somewhere to reduce overlap?

p. 9 Two Beardsley et al. are given on this page with different dates. Is that correct? Are the two references (USFS 1993, 1996) studies or reference to FIA inventory data? It is unclear that FIA data is a system of ecological classification. I assume, as given in the earlier section on Old Forests, that Beardsley et al. made a classification based on FIA data.

p. 11, Management Extensions
There is a finding buried somewhat in this section that I believe could be brought up to the Issues sections and highlighted more, rather than calling it an area of further clarification. It is the sentence discussing the Freel criteria that goes on to suggest "a new approach to conserving old-forest habitat for all species who depend on these forests." This part certainly deserves more attention and is one of the few integrative, new bits of science to come out of the entire review. The next couple of sentences are incomplete.

p. 12. The last item on QLG seems out of place. There is nothing here that couldn't be just noted in passing in the first part of the Issue, perhaps on p.6.

FEMAT and SNEP
p. 15, first paragraph at end. There are plenty of areas where conditions could be improved by non-innovative science-based practices, too.

p. 16. If land management in ADMAs is only directed to make an effort to minimize impacts on aquatic systems, how is the designation different from current policy on public and private lands in the Sierra? Is it FS policy to cause impacts on aquatic habitats from land use at present? ADMAs are dominated by native species (75%) unless they are trout. Note the conflict in this designation with the sections developed under high elevation aquatic/riparian. Reference to the descriptions of each area in Moyle et al. 1996 (Vol. III) shows that "any other characteristics that make them unique" can be anything. Big Chico Creek, for example, is selected in spite of failing to meet any of the other criteria because "...of its high recovery potential." The same might be applied to any watershed.

Comparison of FEMAT and SNEP
The ADMA designation is not a reserve strategy equivalent to key watersheds and refugia as defined by FEMAT. The application of the four or five criteria for ADMA selection can only be judged by examination of the selected watersheds which shows that many are clearly not "in reasonably good condition" or "contained populations of all native aquatic species" or were based on much beyond fish and some other vertebrates.

The comparison of buffers as just a matter of details could as well fit existing policy on all state and federal lands in California. Do not the FS and the State Board of Forestry now also recognize land use buffers of various widths? There is a sense of trivializing the differences inherent in the approaches and the way each builds on distinct views of important system properties. I have the distinct impression from this section that the PSW science team does not understand the real differences between the FEMAT model and the SNEP model for riparian protection.

p. 18. The statement "this approach has yet to be tested" implies that the FEMAT approach has "been tested." And, application of a FEMAT buffer will also require "a mathematical formula" in order to estimate the 100-year floodplain when it applies.

p. 18, last paragraph. I cannot follow the meaning of the first sentence. It has too many components. Can it be divided into smaller, independent thoughts?

Reviewer 8of8:

Comments on Sierra Nevada Science Review

Overall: two other issues that seem important enough to warrant priority for Sierran Conservation are air pollution and invasive exotics (especially plants but also pathogens and animals). These are both incipient and growing problems. There was some mention of exotic plants on the western slopes of the Sierra Nevada, but starthistle and scotch broom are now on the eastside in Sierra Valley at least. Signs of ozone are found above the foothill zone, going up the highway 50 corridor and affecting parts of the eastside, such as in south Lake Tahoe.

Fire and Fuels : overall good discussion and coverage

bullet 13 - important to include that the magnitude of increase in fuel abundance and continuity would vary by system and condition. Subalpine systems have likely changed relatively little. Low productivity sites in general have likely changed little. Red fir has changed less than mixed conifer or eastside. The way this bullet is written, it implies that changes have been uniform.

bullet 20 - The relative terms of ``mesic" used in Minich et al. 1995 is more analogous to dry in much of the comparable Sierra Nevada Forests. Precipitation is lower at the Minch sites than most mixed-conifer forests on the west slopes of the Sierra Nevada.

Old-Forest Ecosystems: (1) Forest Conditions of Structurally Complex Forest types

Although there is discussion in the Introduction about confusion about old-growth, there are a lot of summary statements in this section that add to the confusion because there is in adquate lack of documentation of what the statistics refer to. Were the calculations based upon certain sources of data? What variables were used to assign old-growth condition? It seems that a brief mention of this information would serve to decrease ambiguity and confusion. The term ``structural complex" forest types in the title seems uncessary.

bullet 1 - phrase ``...forest types comprise multiple goegraphic scales" does not read well -does it mean that structural characteristics of old-forests occur at multiple scales?

bullet 2 - the first sentence with the phrase ``both within and outside late-successional stands". In gradient approaches, such as SNEP, this situation does not occur because all stands that have some large trees are considered part of the late-successional gradient.

bullet 6 - what is a ``complete" old forest ecosystem? I have never seen this term applied to assessment of old-growth. Most current thinking is that with variability and diversity in history and condition that gradients and different arrays of attributes occur. The only consistent structural feature of all kinds of old-growth is large, old trees for species and site.

bullet 8 - There have not been any fire history studies in the Sierra Nevada that support the suggestion that forests on lower slopes had more late-successional characteristics. Fites-Kaufman 1997, does suggest that late-successional forests differed in dominant species composition and fire frequency. There was no direct evidence that large diameter trees differed. Further, the only structural changes that seemed likely to infer in this study were higher canopy cover and canopy layering. These structural characteristics are not unique to LSOG forests, they also typically occur in mature or younger forests in certain forest types in the Sierra Nevada. It is not clear how applicable Taylor and Skinner's work is to the Sierra Nevada. Are precipitation regimes similar?

bullet 11 - Session's et al. analysis of LSOG rankings is referred to as ``modeling efforts". In fact, they used Forest Inventory & Analysis plots, as did Beardsley and Langley (he also used SNEP plots). However, Session's et al used the stand data and extrapolated to landscapes, using the SNEP LSOG boundaries. This is likely the reason that the results

showed greater similarity to the SNEP LSOG ranks-scale of evaulation was the same. Differences in the analysis that should be included in this section are the variables used in each: Sessions et al. used large tree density, canopy cover and presence of intermediate canopy; Langely used a series of variables not directly related to the SNEP LSOG classification.

f) bullet 13 - It is not clear from this section what definition Beardsley was using. Further, she used several variants of LSOG criteria. Does total conifer forest include subalpine?

Old-Forest Ecosystems: (2) California Spotted Owl

Relationship with National Forest Management - the statement ``poor fit between existing late successional maps and the locations of suitable owl habitat" does not specify which maps these are. It would be more useful for managers if it did.

General Approaches to Studying Old-Forest Ecosystems

The introduction to the section would be far more useful by deleting the first set of bullets or providing specific references to the approaches used in the Sierra Nevada. As it is now, it is very general and does not contribute greatly to the objective of the section.

There is an obvious lack of reference or discussion on the USFS Regional Old-Growth Definitions and how they relate to the other approaches discussed, nor how they were developed as part of a National Program. The Beardsley analysis and the Lake Tahoe interim guide are both based upon these definitions. Further, although not directly referenced, Old-Growth definitions were used extensively in the construction of the cross-walk tables in the SNEP LSOG analysis.

In addition, there is other recent literature from other regions in the country that discuss overall approaches to defining, inventorying and assessing old-growth that are not referred to for context.

There is no real discussion of the difference in basis for structurally characterizing old-growth or late-successional forests for the primary approaches described. Further, there is no treatment of the two most commonly applied approaches on US Forest Service and other lands, the U.S. Forest Service timber strata, and California Wildlife Habitat Relations. It would be important to note that both of the these approaches are dependent upon mean diameter of the trees in a stand. Whereas, Regional Old-Growth Definitions, Beardsley's analysis, SNEP LSOG, CASPO nest stand descriptions, and preliminary habitat data on mesocarnivores all include large trees, their density and derivatives as key elements. They differ in the application of other elements such as canopy cover, snags, logs, and canopy layering. Even more important is which of the approaches require all elements to be present or not.

``Old-forest scholars" and the ``academic landscape" are not the only significant areas of information or study or old-forest ecosystems. The confusion is at least partly or if not more so as a result of management inventory and analysis approaches.

bullet 1- which authors use soil, litter, and health as attributes for old-forests. Major differences are in tree characteristics whether it is mean diameter or large tree density.

bullet 2 - There is considerable recent research on characterizing old-growth forests in the central, southern and eastern U.S. It is pretty clear that large, old trees with decadence is a common element in old-growth forests from a global perspective. It is also clear from the SNEP LSOG paper and the USFS R5 Old-Growth definitions that the other elements vary widely with the forest type, climate and disturbance regimes.

bullet 3 - the term "species type" is not commonly used...it seems that this is really referring to forest type.

bullet 5 - where are periods of conditions referred to as "ideal" snapshots? I have never seen this used. Because of limited quantitative data, typically one or two specific time periods are often referred to but not as "ideal".

bullet 6 - the last sentence is not very useful without a specific reference to what the "some studies" refers to.

bullet 7 - this last set of statements seems so general as to be not very useful. Clarifications that might improve would include for example: a) what "elements" are weighted as significant to various animal species (large trees?, canopy cover?); b) the major differences in elements used currently varies more with historic use for other purposes (i.e. QMD or average diameter for timber volume estimates) than based upon different current perspectives; c) term "potential vegetation" seems

to be used incorrectly- typically it is more of an ecological concept pertaining to site potential that includes both recent historic, present and near future possible communitites.

Current Approaches to Defining and Inventorying Old-Forests in the Sierra Nevada

The second sentence is vague...to add to the discussion and inform, the approaches that are considered "explicit" and ones that are considered "*ad hoc* and inferential" should be identified.

The fifth sentence in the first paragraph is misleading, since it is unclear whether these varying definitions for one forest type occurs within California only or accross the western U.S.

Two of the most used approaches for defining and inventorying late-successional forests is missing from this section: 1) CWHR, and 2) USFS timber strata. These have been the most used in environmental analyses and in reports to the administration and congress on the status of old-growth in the Sierra Nevada.

SNEP: Structural Complexity: Rangewide Standards (1996)

In the definition section, there is no reference to the discussion on p. 636 in the SNEP paper on LSOG that defines defines old-growth more specifically in terms of forest structure as "large old trees with medium to high decadence, large snags and large logs".

In the section on primary criterion...there is reference to trees > 40". In fact, the diameter of what was considered a large tree varied with site class and forest type. The variation was concordant with the USFS R5 Old-Growth Definitions.

In the paragraph on method of measuring/inventorying...the term "polygon scale" is used. This does not specify that mosaics of repeating patches were delineated and that both the patches and the mosaic were characterized in a database.

It doesn't make sense to separate out the series normalized from range-wide standard approaches. These are related and integral to the SNEP approach. The only distinction was in emphasis in reporting for the objectives of SNEP. Both the series normalized and range-wide approaches are currently being employed for landscape assessments, watershed assessments, and wildlife habitat analysis on national forests in the Sierra Nevada.

Sierra Biodiversity Institute 1990

The authors should contact the Sierra Biodiversity Institute directly concerning the missing information. The emphasis of the Sierra Biodiversity Insitute was in mapping westside mixed-conifer forests. They used supervised classification in the northern Sierra Nevada, based upon a series of known old-growth sites on the ground. They used an iterative process in the southern Sierra Nevada, starting with an unsupervised classification. They did not use any ground data from eastside or upper montane Jeffrey pine or red fir forests. In the section on "Other", the statement is made that "no to low overlap in location of areas mapped occurs". I have just re-read the Davis (1996) paper and do not reach the same conclusion at all. There is a high correspondence between proportion of area mapped as LSOG by the SBI and the rank of LSOG polygons in westside mixed-conifer forests. There is a positive correlation of LSOG rank and proportion of SBI LSOG in red fir and white fir forests, especially in the north (Davis 1996). The stronger relationship in the north is likely due to the use of a supervised vs unsupervised classification in the north. It is primarily in the Jeffrey pine and eastside pine forests that there are more notable discrepancies between the SBI and SNEP LSOG mapping. This is very likely due to the fact that SBI did not use any stands in these forest types to train the spectral classification (Davis 1996). Further, discussions with SBI indicate that there is a high degree of spatial overlap of LSOG in the rank 3,4 & 5 polygons and the SBI LSOG. Much of the discussion in the Davis (1996) comparison is for rank 4 and 5 polygons. In Franklin and Fites-Kaufman (1996) it is clear that a substantial amount of rank 4 and 5 patches occur in the rank 3 polygon

USFS: Forest Inventory & Analysis; Ecological Classification (USFS 1995, 1996, Beardsley et al. 1998)

The definition section does not specify that the USFS Region 5 Old-Growth Definitions were the basis for defining old-growth in this analysis. In this section and the following this work and the ecological classifications should be cited. Further, the data used to develop the Old-Growth Definitions were not just from the ecological classification sampling but also other sources including Forest Inventory, Stand Exam, and Widlife Habitat Inventories (see especially the mixed-conifer and white fir definitions).

In the section on method of inventorying and measuring..it would be much more useful to display the different combinations of variables used by Beardsely et al. 1998. Cover of shrubs and forbs is listed as inventoried attributes, but were these used in Beardsley's analysis?

In the other section, there is a statement that "only those plots with 90% correct implementation (criteria set) were used". What does this mean?

This classification used by Beardsley was the SAF set of Forest Type definitions, not an ecological classification.

This section is very lacking in also discussing either here or as a following section the timber strata approach. This is critical for understanding the structural criteria used to develop the maps that the inventory Beardsley used is base on. Further, in and of itself, it continues to be the primary means of mapping forest structure in the Sierra Nevada and therefore should be addressed thoroughly. For the Landscape Analysis, Eldorado Timber Sale Reconsideration, Fites et al. found very little correspondence between timber strata size classes and the presence and amount of old-growth structure. Fites-Kaufman et al. also have a paper in preparation displaying the same results for the Tahoe National Forest. This casts uncertainty into the analysis conducted by Beardsley et al. .

Spotted Owl Habitat, CASPO Interim Guidelines (Verner et al 1992, USFS 1995, USFS 1996)

The definition and methods of measuring and inventorying sections do not reflect the primary forest service approach for spotted owl habitat. While the CASPO technical report defines habitat in terms of specific structural elements such as large tree basal area or density, large snags, logs, and total basal area, R5 of the forest service typically employs the timber strata classification based upon quadratic mean diameter of trees and canopy cover to measure and inventory spotted owl habitat. The distinction between these two seem critical to this overall portion of the review and for utility by managers.

Lake Tahoe Forest Health Consensus Group (FHCG) 1998

The definitions and approaches used by the FHCG are based to a large degree on two other old-growth sources: 1) USFS Old-Growth Definitions, and 2) SNEP LSOG series normalized approach. Currently, the old-growth structure of forests in the Lake Tahoe Basin are being mapped by updating older photo-interpreted maps of vegetation with large tree density and for changes in density and/or species.

Issue: AQUATIC, RIPARIAN, AND MEADOW ECOSYSTEMS: (1) LOW- TO MID-ELEVATION

In the last bullet the second sentence seems overly generalizing. The recent data that I am aware of in the Sierra Nevada (Fites-Kaufman 1997) suggests that fire occurred in many riparian areas and was frequent in some.

Issue ROADS

This entire section seems to be different in tone than the rest of the review. Frequently throughout there seem to be references to advocating roads such as "Developing a premise for new road construction that will garner greater public support is essential". Where is this from and what relevance does it have to a review of scientific information?

APPENDIX III: CHARGE TO THE SCIENCE TEAM

The charge to the science team is described in a letter dated June 12, 1998 from PSW Research Station Assistant Director Garland Mason, which invited participation in a self-directed team to complete a task more fully described in an attached letter that Station Director, Hal Salwasser June 12, 1998 wrote to Mason. Salwasser's letter to Mason is duplicated here:

"The release on May 1, 1998 of Regional Forester Sprague's policy letter for the Sierra Nevada marked the start of a new phase in the PSW Research Station's work with the Region. Implementing the May 1 letter, specifically assisting the Region with oversight review of adaptive management and assisting with forest carnivore conservation, is already involving Drs. Jared Verner and William Zielinski. We now need to accelerate work that our scientists have been doing informally for several weeks on Task 2 (summarized in Regional Forester Sprague's May 1 letter). With this letter, I am asking you to convene and coordinate a team of scientists to complete Task 2, and I am clarifying my expectations for the Sierra Nevada Science Review and your role in developing it.

"Prior to and since the PSW Region issued interim guidelines for protecting California spotted owl habitat in 1993 (CASPO Interim Guidelines), much new science information has become available relevant to resource conservation and management in the Sierra. This new information is primarily contained in reports of the Sierra Nevada Ecosystem Project (SNEP), and also in several other research reports. At a minimum, the resource concerns that appear to have substantial new information, as identified in the Federal Advisory Committee Report on the California Spotted Owl Revised Draft Environmental Impact Statement, include California spotted owls, old forests, aquatic and riparian ecosystems, forest carnivores (also known as forest carnivores or furbearers), roadless areas, and forest fuels and their effects on fire management and other resource values. We have also heard repeatedly, concerns expressed by various people who live and work in the Sierra about the effects of CASPO Interim Guidelines on the above resources as well as on environmental and socioeconomic conditions of Sierra Nevada ecosystems and regional communities. The Forest Service is required to review ongoing management of national forests in light of new information and consider adjusting management if necessary and appropriate.

"Please assemble a self-directed, interdisciplinary science team of PSW scientists under our Reinvention Laboratory authority to provide a review, or synthesis, of new, relevant scientific information on the Sierra for the Region. This review will help focus the Region's concurrent work to decide whether, and if so, how, to amend management plans for national forests in the Sierra Nevada. Specifically I ask your team to develop a report that:

"1. Identifies new scientific information not available during the formulation of existing management direction and its implications for resource management, conservation, and environmental and socioeconomic conditions, and which, from a scientific standpoint, bears on the adequacy of existing management direction for national forests in the Sierra. The team may document applicable new scientific information on ecosystem conditions and resource concerns beyond those noted above.

"2. Identifies geographic and institutional scales at which the new information would be most appropriately addressed by analysis and conservation planning.

"3. Identifies those aspects of each resource concern that, due to interrelationships between the resource and ecosystem concerns, should be coordinated and integrated in analysis and planning.

"4. Identifies resource concerns for which science is unresolved. These include issues or concerns that need further discussion in the science community before it is clear how new scientific information affects current management and how best to translate the information into reasonable management proposals.

"As part of concurrent and subsequent work to amend forest plans (Task 3 in Regional Forester Sprague's letter, not this assignment), a Science Integration Team will be designated to work with the Region to integrate new science information into planning and to address the unresolved science issues from either item four of this review, or from further public scoping as part of the NEPA process. The goal of the Science Integration Team's work regarding unresolved science issues will be to clarify interpretations adequately for the national forests to apply them in management planning. For this Task 2 report, I ask the self-directed team to list the unresolved science issues and briefly summarize why they deserve further clarification within the NEPA process.

"I am designating you to coordinate the self-directed team on the Task 2 Sierra Nevada Science review, to report regularly to me and the Chief's office on progress, to work with Regional staff, other Federal and State agency scientists, and appropriate nongovernmental scientists as your team develops the report, and to ensure timely delivery of the final report. Please develop the draft following these guidelines:

"* Limit the body of the report to 30 pages if possible.

"* Focus on issues of urgency for the Forest Service in the Sierra Nevada (especially those noted in paragraph 2 of this letter), issues that are specific to Sierran national forests, the lands and resources they administer, and issues within their direct influence."

"* Develop Part I of the report as Priority Issues for Conservation, with one section per issue, and headings as follows: Issue, Synopsis (with references), Basis for Inclusion, Geographic Region of Concern, Primary Scales for Conservation, and Relationship to national forest management.

"* Part II of the report should document the Unresolved Issues, and the remaining sections and appendices should include studies consulted and general references, Task 2 team members, distribution list of drafts, and blind peer review process.

"* Given that the Region's planning process might start while the Sierra Nevada Science Review is underway and needs rapid input from the Review, timelines are as follows: first draft for external science review June 19; revised, second draft by July 10; blind peer review by July 17; final report by July 24.

"The time commitment for scientists involved in this project will largely be in drafting and reviewing initial drafts and helping in the revision of subsequent drafts after external and peer review. After the team has developed the first draft, please coordinate a quick, external, interagency review involving scientists from diverse backgrounds (agency, academic, and otherwise) who are knowledgeable about the Sierra Nevada. The purpose of this review is to ensure that the PSW team has been sufficiently comprehensive and objective in its first draft. I expect you to obtain a breadth of perspectives and disciplinary expertise in this review. Copies of this first draft will be available to interested parties (for instance, using the SNEP key contacts) so they are aware of the process we are using. When the team has revised the report into a second draft, you are to coordinate a blind peer review prior to final revision and release. Keep the PSW Regional staff informed throughout.

"I ask that you engage PSW and other scientists on this task to work not only within their area of specific expertise but broadly as scholars of resource science in the Sierra Nevada. I call on PSW scientists, to the best of their ability, to broadly represent their peers in the science community as well as their own scientific perspectives."

APPENDIX IV: SCIENCE REVIEW TEAM

All team members are scientists at the USDA Forest Service, Pacific Southwest Research Station. Station localities are given for each team member.

AMY LIND
Research Herpetologist
Arcata, CA

CONSTANCE MILLAR
Research Geneticist
Albany, CA

ROWAN ROWNTREE
Research Biogeographer
Albany, CA

CARL SKINNER
Research Geographer
Redding, CA

JARED VERNER
Research Wildlife Biologist
Fresno, CA

WILLIAM ZIELINSKI
Research Wildlife Biologist
Arcata, CA

ROBERT ZIEMER
Research Hydrologist
Arcata, CA

Section Contributors:

LESLIE REID
Research Geologist, USDA Forest Service, PSW Research Station,
Arcata, CA
(Contributed to Appendix I, Part 2; FEMAT and SNEP: A Comparison of Approaches to Management of Aquatic and Riparian Systems.)

JOHN KEANE
Wildlife Ecologist, USDA Forest Service, Stanislaus National Forest
Sonora, CA
(Contributed information and bulleted statements on northern goshawk.)

APPENDIX V: PEER REVIEW LIST

The Science Team invited select reviews and offered optional review from a large number of specialists and scientists on several draft versions. Some individuals volunteered unsolicited comments. Review comments received in time for consideration in revisions included comments on parts or whole drafts from:

Dr. Reginald Barrett, University of California, Berkeley CA
Mr. Thomas Beck, USFS Stanislaus National Forest, Sonora CA
Mr. Steve Bishop, USFS, PSW Regional Office, San Francisco CA
Mr. Louis Blumberg, The Wilderness Society, Sacramento CA
Mr. John Buckley, Central Sierra Environmental Resource Center, Twain Harte CA
Dr. Sue Britting, Sierra Nevada Forest Protection Campaign, Sacramento CA
Mr. Mike Chapel, USFS Regional Office, Nevada City CA
Mr. Ron Cowan, The Quercus Group, Richmond California
Dr. Tim Duane, University of California, Berkeley
Dr. JoAnn Fites, USFS, Plumas and Lassen National Forests, Quincy CA
Mr. John Frazier, USFS, Stanislaus National Forest, Sonora CA
Dr. Richard Golightly, Humboldt State University, Arcata CA
Dr. Dave Graber, Sequoia-Kings Canyon National Park, Three Rivers CA
Dr. Greg Greenwood, California Department of Forestry and Fire Protection, Sacramento CA
Mr. John Hofmann, California Forestry Association, Sacramento CA
Mr. John Keane, USFS, Stanislaus National Forest, Sonora CA
Dr. Roland Knapp, University of California Sierra Nevada Aquatic Research Lab, Mammoth Lakes, CA
Dr. Thomas Kucera, National Park Service, Pt. Reyes CA
Dr. Jonathan Kusel, Forest Community Research,
Ms. Pat Manley, USFS Regional Office, S. Lk. Tahoe CA
Dr. Kathleen Matthews, USFS PSW Research Station, Albany CA
Dr. Mark Nechodom, University of California, Davis CA
Ms. Ginelle O'Connor, Inyo National Forest, Lee Vining CA
Dr. Dave Parsons, Wilderness Research Institute, USFS, Missoula MT
Dr. Linda Reynolds, Inyo National Forest, Bishop CA
Mr. Ken Roby, Plumas National Forest, Quincy CA
Mr. Richard Truex, University of California, Berkeley CA
Dr. Hart Welsh, USFS, Pacific Southwest Research Station, Arcata CA
Dr. Wallace Woolfenden, USFS, Inyo National Forest, Lee Vining CA

APPENDIX VI: DISTRIBUTION LIST

Working drafts were distributed in the following ways:

June 7, 1998 Draft

Copies to:
- PSW Science Review Team.
- Washington Office, USFS.
- Regional Office, USFS.

June 16 (and slightly revised June 19) Draft

Posted to Website: www.psw.fs.fed.us/sierra/.
Electronic notices regarding website access to New Perspectives mailing list (internal/external ecosystem management), to PSW Region national forests, to Sierran Province Assessment and Monitoring Team
Letters informing of draft access on web or offering a copy in mail were sent to over 250 addresses
(individuals, special interest groups, etc.). A copy of the list of names is in the Administrative Files of the PSW Research Station, Albany CA.

Copies to:
- Washington Office, USFS
- Dr. Charles Philpot, Chair, California Spotted Owl Federal Advisory Committee
- Dr. William McKillop, Chair Senate California Forest EIS Review Committee
- Members of Congress

July 10 Draft

Posted to Website: www.psw.fs.fed.us/sierra/.
Distributed to eight scientists for blind peer review.
Copies to Washington Office, USFS